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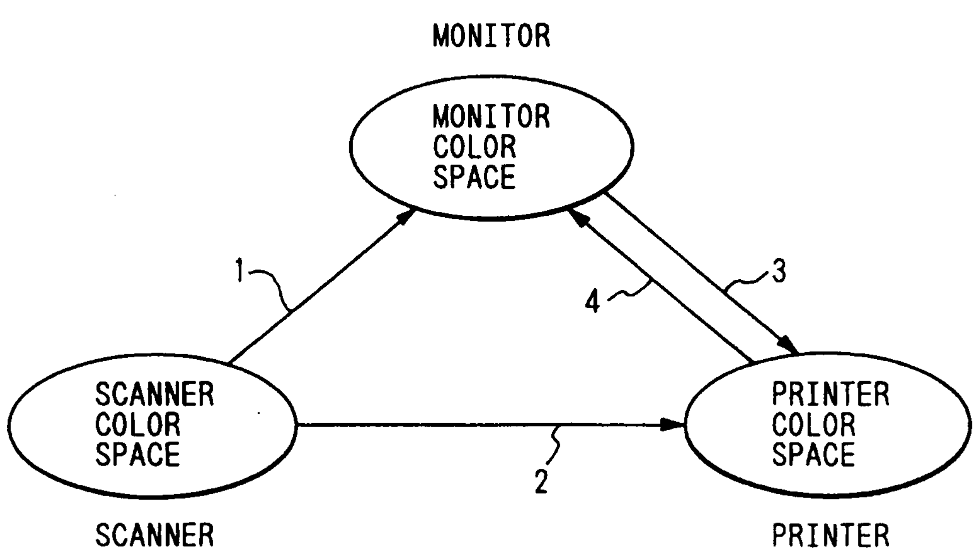
(54) Image processing apparatus and method.

(57) It is an object of the present invention to provide an image processing apparatus and method which allows the user to select a color matching process according to an application and to execute the selected process for image processing.

To achieve the above objective, designating means (console unit) for designating one of a plurality of processes of realizing a color matching method, a device profile storage unit for storing information for use with the processes, and selecting means for selecting one piece of information from the stored information based on the designating means are provided, and color image data is processed based on the selected process.

FIG. 1



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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image processing apparatus and an image processing method for image processing in a color management system or the like to faithfully reproduce colors.

Related Background Art

As shown in Fig. 40, a color gamut is different from device to device, such as scanner, monitor, printer and the like.

In Fig. 40, x and y denote chromaticity coordinates, and the inside of a graphic is a color gamut.

That is, to reproduce colors absorbing a difference in color gamut, a problem is how a color in a nonoverlapping gamut is to be handled.

For example, a monitor color space is to be converted to a printer color space, a problem is which printer color is used to express a color falling in the monitor color space, but not in the printer color space.

A process related to this is called a color gamut compression process (or color space compression process).

A color gamut compression method is the one for mapping image data to colors expressible on an output device and is usually called CMM (color matching method).

However, in a conventional color management system, only one process method is available for implementing the color matching method.

In the color space conversion process between devices such as scanner, monitor, printer and the like, what process including color space compression is to be executed, i.e. a process method does not depend on devices, but information used for a process depends on devices.

The abovementioned information is stored in a file called a device profile.

For example, the profile of a monitor contains data describing monitor characteristics such as x-y chromaticity values of red, green, blue and white, data on gamma characteristic curves for red, green and blue and the like for the monitor.

Device profiles, as shown in Fig. 41, are called scanner profile, monitor profile, and printer profile in correspondence with individual devices.

In the abovementioned color space conversion, a process is executed using a profile corresponding to a source device and a profile corresponding to a destination device. The former profile is called a source profile, and the latter profile is called a destination profile.

For example, in a conversion from the scanner color space to the monitor color space, the source device is a scanner, and the profile of the scanner is a source profile, while the destination device is a monitor, and the profile of the monitor is a destination profile.

The abovementioned method has involved a problem of a failure to execute image processing by selecting a process of realizing one color matching method according to an application.

SUMMARY OF THE INVENTION

It is a concern of the present invention to provide an image processing apparatus and method which has solved the abovementioned problem.

It is another concern of the present invention to allow a process of realizing a color matching process method according to an application of function.

It is a further concern of the present invention to allow a color matching process using default information even when a designated color matching process is not available.

It is still another concern of the present invention to allow a color matching process method to be selected based on the accuracy of a color matching process.

It is still further concern of the present invention to allow a color matching process method to be selected based on time required for a color matching process, i.e. processing time.

It is still further concern of the present invention to establish the correspondence of information about a color matching process method with the type of a color matching process method and a process type.

Thus there is provided an image processing apparatus according to a preferred embodiment of the present invention which has designating means for designating one of a plurality of processes of realizing a predetermined type of a color matching method and selecting means for selecting information for use with the designated process and which processes color image data using the selected information.

Other features of the present invention will be apparent from the following description of embodiments and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an example of color reproduction in a color management system;
Fig. 2 is a block diagram showing the circuit configuration of an image processing system according to an embodiment of the present invention;
Fig. 3 shows a profile address table;
Fig. 4 is a flow chart showing a process of outputting color image data read from a color scanner to a color printer after executing a color matching process thereon;
Fig. 5 exemplifies a case where when a plurality of color matching process methods are available, there exist a plurality of device profiles having information for the processes;
Fig. 6 shows an example of a profile structure;
Fig. 7 shows an example of the structure of a header information unit;
Fig. 8 shows an example of the structure of a CMM process information storage unit;
Fig. 9 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and executing the selected color matching process;
Fig. 10 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and executing the selected color matching process;
Fig. 11 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and executing the selected color matching process;
Fig. 12 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and executing the selected color matching process;
Fig. 13 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and executing the selected color matching process;
Fig. 14 exemplifies a case where when a plurality of color matching process methods are available, there exists one device profile having information for the processes;
Fig. 15 shows an example of the structure of a header information unit;
Fig. 16 shows an example of the structure of a CMM process information storage unit;
Fig. 17 shows an example of the structure of a data storage unit for CMM;
Fig. 18 shows an example of the structure of data for CMM;
Fig. 19 shows an example of the structure of data for a process method;
Fig. 20 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 21 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 22 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 23 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 24 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 25 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 26 is a flow chart showing a process of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and executing the selected color matching process;
Fig. 27 shows an example of the process of step S115 of Fig. 11 or of step S224 of Fig. 23;
Fig. 28 shows an example of the process of step S127 of Fig. 13 or of step S245 of Fig. 26;
Fig. 29 shows a relational expression between XYZ data provided for by CIE and RGB data;
Fig. 30 shows a relational expression between XYZ data provided for by CIE and RGB data;
Fig. 31 shows an example of the process of step S31 of Fig. 28;
Fig. 32 shows an example of a table for use with process 1 of Fig. 31;
Fig. 33 shows an example of a table for use with process 4 of Fig. 31;
Fig. 34 shows an example of a table for use with process 3 of Fig. 31;
Fig. 35 shows an example of the process of step S127 of Fig. 13 or of step S245 of Fig. 26;
Fig. 36 shows an example of conversion from XYZ data provided for by CIE to $L^*a^*b^*$;
Fig. 37 shows an example of the notion of CMM;

Fig. 38 shows an example of three-dimensional LUT;
Fig. 39 is an enlarged view exemplifying one solid of lattice containing an input L*a*b* value to LUT;
Fig. 40 shows an example illustrating a difference in color gamut among devices;
Fig. 41 shows an example of a device profile type;
Fig. 42 shows an example of the structure of a header information unit;
Fig. 43 is a flow chart showing a process of selecting a destination profile according to a color matching method described in a source profile for image data and executing color matching accordingly;
Fig. 44 is a flow chart showing a process of selecting a destination profile according to a color matching method described in a source profile for image data and executing color matching accordingly;
Fig. 45 is a flow chart showing a process of selecting a destination profile according to a color matching method described in a source profile for image data and executing color matching accordingly;
Fig. 46 is a flow chart showing the process of step S515 of Fig. 44;
Fig. 47 is a flow chart showing the process of step S515 of Fig. 44;
Fig. 48 is a flow chart showing a process of fetching information for use with the process of a designated color matching method from a source profile and a destination profile and executing color matching accordingly;
Fig. 49 is a flow chart showing a process of fetching information for use with the process of a designated color matching method from a source profile and a destination profile and executing color matching accordingly;
Fig. 50 is a flow chart showing a process of fetching information for use with the process of a designated color matching method from a source profile and a destination profile and executing color matching accordingly;
Fig. 51 is a flow chart showing the process of step S713 of Fig. 50;
Fig. 52 is a flow chart showing the process of step S713 of Fig. 50; and
Fig. 53 is a flow chart showing the process of step S713 of Fig. 50.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows an example of color reproduction in a color management system.

The color management system executes color matching in due consideration of characteristics of color input/output devices.

Three basic color input/output devices, i.e. color scanner, color monitor and color printer, are taken up herein.

In the color management system, characteristics of these three devices need to be considered in a color reproduction process (color matching process), i.e. four color space conversion processes denoted with arrows in Fig. 1.

1. Conversion process from scanner color space to monitor color space
   A process for faithfully displaying photograph data read from the scanner on the monitor.
2. Conversion process from scanner color space to printer color space
   A process for faithfully printing photograph data read from the scanner on the printer.
3. Conversion process from monitor color space to printer color space
   A process for faithfully printing character data, graphics data and the like which have been prepared on the monitor using application software, on the printer.
4. Conversion process from printer color space to monitor color space
   A process for previewing the results of printing on the printer on the monitor.

The abovementioned color spaces of three devices depend on individual devices and are different in color gamut as shown in Fig. 40.

There are a plurality of conceivable methods for reproducing colors absorbing the difference in color gamut, which methods are executed in the abovementioned color space conversion processes.

Fig. 37 shows an example of a color gamut compression process.

A color gamut compression method is the one for mapping image data to colors expressible on an output device and is usually called CMM (color matching method).

Three typical examples of CMM will be taken up herein.

A first CMM is a method which utilizes human's perception as shown at lower left of Fig. 37.

In the first CMM, the most light and dark colors of image data are matched to the light and dark colors of an output device, respectively, and other colors are converted in such a manner as to maintain their relation with the most light and dark colors.

A second CMM is a method which leaves the overlapped portion of image data and the color gamut of the

output device intact and which maps a nonoverlapping portion onto the outer edge of the color gamut of a destination of conversion with lightness thereof being saved.

A third CMM is a method which compresses a nonoverlapping portion of image data and the color gamut of the output device with saturation thereof being saved.

That is, the first CMM has a feature of attaching importance to lightness, the second CMM has a feature of faithfully reproducing such a gamut that is faithfully reproducible, and the third CMM has a feature of maintaining tone of a whole image.

Thus, it is impossible to faithfully reproduce image data falling outside the color gamut of an output device. Hence, CMM having an appropriate feature is executed for reproducing an image as close to an original as possible.

It is therefore necessary to select CMM according to characteristics of input image data.

Specific characteristics of input image data include image pictures, CG images (character data, drawing commands) and the like.

That is, the abovementioned selection intends to execute an optimum CMM based on characteristics of image data.

In contrast to this, it is necessary to change the process of CMM according to user's applications.

In details, for example, the process of CMM should be different depending on whether the user wants color matching at a high accuracy or at a high speed.

Thus, first and second embodiments described in detail below have a plurality of CMMs corresponding to combinations of types and processes of CMM.

Fig. 2 is a block diagram showing the circuit configuration of an image processing system according to an embodiment of the present invention.

As shown in Fig. 2, the image processing system according to the present embodiment comprises a color monitor 1, a host computer 2, a color printer 3, and a color scanner 4.

The host computer 2 processes image data or the like read from the color scanner 4 and displays the results of processing on the color monitor 1 or prints on the color printer 3. In details, the host computer 2 has a monitor interface 21 for transmitting data to and from the color monitor 1, VRAM 22 used for display on the monitor, CPU 23 comprising ROM and RAM and controlling a whole system, a frame memory 24 used for display on the monitor, a print buffer 25 used for output to the printer, a printer interface 26 for transmitting data to and from the color printer 3, a device profile storage unit 27 for storing device profiles including color gamut information tables and other information, a color gamut check unit 28 for determining whether input color image data is present or not in the color gamut, a color conversion unit 29 for executing color space conversion associated with color reproduction, a color reproduction process unit 2a for executing a color reproduction process based on the results of determination at the color gamut check unit 28, a scanner interface 2b for transmitting data to and from the color scanner 4, a data bus 2c, and a console unit 2d used by the user for inputting instructions to the host computer by means of a mouse, keyboard or the like.

Fig. 3 shows an example of a profile address table stored in the device profile storage unit 27. m (constant) device profiles are stored.

The color space conversion process 2 in Fig. 1 will now be described in detail as an example of process.

Fig. 4 is a flow chart showing a process of outputting color image data (RGB brightness data) read from the color scanner 4 to the color printer 4 after executing a color matching process thereon.

At step S10, a set of color image data (RGB brightness data) is read out of the color image data read from the scanner 4, and then processing proceeds to step S11.

The abovementioned data is RGB data which depends on display characteristics of the color scanner 4, such as gamma characteristic and the like, and which is colorimetrically defined (a chromaticity value is definite for R, G, B and white).

The RGB data read at step S11 undergoes a color matching process at the color reproduction process unit 2a to be converted to CMYK data dependent on the color printer 3, and then processing proceeds to step S12.

The CMYK data converted at step S12 is stored in the print buffer 25, and then processing proceeds to step S13.

At step S13, it is checked whether remaining color image data is present.

If present, processing returns to step S10.

If absent, processing proceeds to step S14 to output the CMYK data stored in the print buffer to the color printer 3 and then terminates.

(First embodiment)

The present embodiment relates to an example of a process where information for use with a plurality of

processes to realize one type of CMM is stored in corresponding independent device files, information for a selected process is fetched from a corresponding device profile, and the selected process is executed on color image data read from a scanner for color matching.

By storing information in independent device profiles, for example, when one piece of information is to be modified, the modification may be done in device profile units, thereby rendering the handling of data easy.

Fig. 5 shows that when there are n (n is a constant) process methods for realizing color matching called CMM1, the process methods featuring high accuracy, high speed and the like, respectively, device profiles number in up to n.

Fig. 6 shows an example of the structure of a profile.

Here, the profile comprises the following three areas: a header information unit to store profile management information, a CMM process information storage unit to store information for a CMM process, and an information storage unit for device color gamut check for checking a device color gamut.

Fig. 7 shows the structure of the header information unit.

Here, the header information unit stores a device model as information about an object device of a profile, a data size as data size information of a profile, a version for profile management, CMMSubtype as classification information of CMM, CMprocesstype as classification information of a process to realize a method of CMMSubtype, Gamutchecktype as information indicating which device color gamut check method a profile corresponds to, information about an offset value for the CMM process information storage unit of Fig. 6, and information about an offset value for the information storage unit for device color gamut check of Fig. 6.

Fig. 8 shows the structure of the CMM process information storage unit of Fig. 6.

Here, the CMM process information storage unit stores a data size for a CMM process corresponding to a profile and data for the CMM process.

Figs. 9 to 13 show flow charts illustrating a process at the color reproduction process unit 2a of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 5 to 8 and of executing a conversion process from the scanner color space to the printer color space, i.e. a color gamut compression process, the conversion process being described above as an example of a selected color matching process.

At step S100, the device model information of a scanner in use, which is a source device, is set for smodel. Then, processing proceeds to step S101.

At step S101, the device model information of a printer in use, which is a destination device, is set for pmodel. Then, processing proceeds to step S102.

At step S102, classification information of CMM designated from the console unit 2d is set for CMMtype. Then, processing proceeds to step S103.

Likewise, at step S103, classification information of a CMM process designated from the console unit 2d is set for processtype. Then, processing proceeds to step S104.

At step S104, a pointer is set to the head of the profile address table of Fig. 3. Then, processing proceeds to step S105.

At step S105, 1 is set for constant i. Then, processing proceeds to step S106.

At step S106, the value of i and the value of m (constant) indicative of the number of profiles are compared. If i is greater than m, processing terminates.

If not, processing proceeds to step S107. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with smodel.

If not equal, processing proceeds to step S110. i and the pointer are incremented by one, and then processing returns to step S106.

If equal at step S107, processing proceeds to step S108. CMMsubtype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S110. i and the pointer are incremented by one, and then processing returns to step S106.

If equal at step S108, processing proceeds to step S109. CMprocesstype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with processtype.

If not equal, processing proceeds to step S110. i and the pointer are incremented by one, and then processing returns to step S106.

If equal at step S109, processing proceeds to step S111. The head address of a profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S112.

At step S112, an offset value for the CMM process information storage unit is set for adr2. Then, processing proceeds to step S113.

At step S113, a pointer is set to adr1 + adr2. Then, processing proceeds to step S114.

At step S114, a pointer is set to the head of data for CMM process in the CMM process information storage unit of Fig. 8. Then, processing proceeds to step S115.

At step S115, a CMM process is executed to correct scanner characteristics on the basis of data dependent on scanner characteristics using the data for CMM process pointed by the pointer. Then, processing proceeds to step S116.

At step S116, a pointer is set to the head of the profile address table of Fig. 3. Then, processing proceeds to step S117.

At step S117, 1 is set for constant i. Then, processing proceeds to step S118.

At step S118, the value of i and the value of m (constant) indicative of the number of profiles are compared. If i is greater than m, processing terminates.

If not, processing proceeds to step S119. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with pmodel.

If not equal, processing proceeds to step S122. i and the pointer are incremented by one, and then processing returns to step S118.

If equal at step S119, processing proceeds to step S120. CMMsubtype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S122. i and the pointer are incremented by one, and then processing returns to step S118.

If equal at step S120, processing proceeds to step S121. CMprocesstype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with processtype.

If not equal, processing proceeds to step S112. i and the pointer are incremented by one, and then processing returns to step S118.

If equal at step S121, processing proceeds to step S123. The head address of a profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S124.

At step S124, an offset value for the CMM process information storage unit is set for adr2. Then, processing proceeds to step S125.

At step S125, a pointer is set to adr1 + adr2. Then, processing proceeds to step S126.

At step S126, a pointer is set to the head of data for CMM process in the CMM process information storage unit of Fig. 8. Then, processing proceeds to step S127.

At step S127, a CMM process is executed for conversion to data dependent on printer characteristics using the data for CMM process pointed by the pointer. Then, processing terminates.

That is, according to the process described above, at steps S100 to S103, each piece of information is set for executing a CMM process designated by the user from the console unit 2c. At steps S104 to S115, for executing a designated CMM process at a designated scanner, a process dependent on designated scanner characteristics is executed using a source profile. Likewise, at steps S116 to S127, a process dependent on designated printer characteristics is executed using a destination profile.

Thus, when a certain type of CMM and a CMM process are designated, independent device profiles (scanner and printer profiles in this example) which have information corresponding to the designated method and process and which correspond to a source device and a destination device, respectively, are selected. Based on information contained in the device profiles, a color matching process can be executed.

(Second embodiment)

The present embodiment relates to a process where information about a plurality of processes for a certain type of CMM is stored in one device profile, information for a selected CMM process is fetched from the device profile, and the selected process is executed on color image data read from a scanner for color matching.

Since information about a plurality of processes is stored in one device profile, reading designated information or the like is easy to manage.

Fig. 14 shows that even when there are n (n is a constant) process methods for realizing color matching called CMM1, only one device profile is involved.

An example of the structure of the profile described above is identical to the example in Fig. 6.

Fig. 15 shows the structure of the header information unit.

Here, the header information unit stores a device model as information about an object device of a profile, a data size as data size information of a profile, a version for profile management, Gamutchecktype as information indicating which device color gamut check method a profile corresponds to, information about an offset

value for the CMM process information storage unit of Fig. 6, and information about an offset value for the information storage unit for device color gamut check of Fig. 6.

Fig. 16 shows the structure of the CMM process information storage unit of Fig. 6.

Here, the CMM process information storage unit comprises a header unit which manages data for l (constant) types of CMMs and a data storage unit for CMM which stores data for l (constant) types of CMMs.

Fig. 17 shows the structure of the data storage unit for CMM of Fig. 16.

Here, the data storage unit for CMM stores CMMsubtype as classification information of CMM, information about data size for CMM, and the head address of data for CMM.

Fig. 18 shows the structure of the data storage unit for CMM of Fig. 17.

Here, the data storage unit for CMM comprises a header unit which manages data for n (constant) process methods for CMM and a data storage unit for process methods which stores data for n (constant) process methods for CMM.

Fig. 19 shows the structure of the data storage unit for process methods of Fig. 18.

Here, the data storage unit for process methods stores CMprocesstype as classification information of a CMM process, information about the size of data for a CMM process, and the head address of data for a CMM process.

Figs. 20 to 26 show flow charts illustrating a process at the color reproduction process unit 2a of fetching information for a selected color matching process from a corresponding device profile shown in Figs. 14 to 19 and of executing a conversion process from the scanner color space to the printer color space, the conversion process being described above as an example of a selected color matching process.

At step S200, the device model information of a scanner in use is set for smodel. Then, processing proceeds to step S201.

At step S201, the device model information of a printer in use is set for pmodel. Then, processing proceeds to step S202.

At step S202, classification information of CMM designated from the console unit 2d is set for CMMtype. Then, processing proceeds to step S203.

Likewise, at step S203, classification information of a CMM process designated from the console unit 2d is set for Processtype. Then, processing proceeds to step S204.

At step S204, a pointer is set to the head of the profile address table of Fig. 3. Then, processing proceeds to step S205.

At step S205, 1 is set for constant i. Then, processing proceeds to step S206.

At step S206, the value of i and the value of m (constant) indicative of the number of profiles are compared.

If i is greater than m, processing terminates.

If not, processing proceeds to step S207. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with smodel.

If not equal, processing proceeds to step S208. i and the pointer are incremented by one, and then processing returns to step S206.

If equal at step S207, processing proceeds to step S209. The head address of a profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S210.

At step S210, an offset value for the CMM process information storage unit is set for adr2. Then, processing proceeds to step S211.

At step S211, a pointer is set to adr1 + adr2. Then, processing proceeds to step S212.

At step S212, a pointer is set to the head of a header for CMM1 in the CMM process information storage unit of Fig. 16. Then, processing proceeds to step S213.

At step S213, 1 is set for constant j. Then, processing proceeds to step S214.

At step S214, the value of j and the corresponding value of l (constant) indicative of the number of CMMs are compared.

If j is greater than l, processing terminates.

If not, processing proceeds to step S215. CMMsubtype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S216. j is incremented by one, and the pointer is set to the head of a header for a next CMM. Then, processing returns to step S214.

If equal at step S215, processing proceeds to step S217. A pointer is set to the head address of data for CMM of Fig. 17, and then processing proceeds to step S218.

At step S218, a pointer is set to the head of a header for process method1 of Fig. 18. Then, processing proceeds to step S219.

At step S219, 1 is set for constant k. Then, processing proceeds to step S220.

At step S220, the value of k and the corresponding value of n (constant) indicative of the number of CMM processes are compared.

If k is greater than n, processing terminates.

If not, processing proceeds to step S221. CMprocesstype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with Processtype.

If not equal, processing proceeds to step S222. k is incremented by one, and the pointer is set to the head of a header for a next process method. Then, processing returns to step S220.

If equal at step S221, processing proceeds to step S223. A pointer is set to the head address of data for process of Fig. 19. Then, processing proceeds to step S224.

At step S224, a CMM process is executed to correct scanner characteristics on the basis of data indicative of scanner characteristics using data for process pointed by the pointer. Then, processing proceeds to step S225.

At step S225, a pointer is set to the head of the profile address table of Fig. 3. Then, processing proceeds to step S226.

At step S226, 1 is set for constant i. Then, processing proceeds to step S227.

At step S227, the value of i and the value of m (constant) indicative of the number of profiles are compared.

If i is greater than m, processing terminates.

If not, processing proceeds to step S228. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with pmodel.

If not equal, processing proceeds to step S229. i and the pointer are incremented by one, and then processing returns to step S227.

If equal at step S228, processing proceeds to step S230. The head address of a profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S231.

At step S231, an offset value for the CMM process information storage unit is set for adr2. Then, processing proceeds to step S232.

At step S232, a pointer is set to adr1 + adr2. Then, processing proceeds to step S233.

At step S233, a pointer is set to the head of a header for CMM1 in the CMM process information storage unit of Fig. 16. Then, processing proceeds to step S234.

At step S234, 1 is set for constant j. Then, processing proceeds to step S235.

At step S235, the value of j and the corresponding value of l (constant) indicative of the number of CMMs are compared.

If j is greater than l, processing terminates.

If not, processing proceeds to step S236. CMMsubtype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S237. j is incremented by one, and the pointer is set to the head of a header for a next CMM. Then, processing returns to step S235.

If equal at step S236, processing proceeds to step S238. A pointer is set to the head address of data for CMM of Fig. 17, and then processing proceeds to step S239.

At step S239, a pointer is set to the head of a header for process method1 of Fig. 19. Then, processing proceeds to step S240.

At step S240, 1 is set for constant k. Then, processing proceeds to step S241.

At step S241, the value of k and the corresponding value of n (constant) indicative of the number of CMM processes are compared.

If k is greater than n, processing terminates.

If not, processing proceeds to step S242. CMprocesstype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with Processtype.

If not equal, processing proceeds to step S243. k is incremented by one, and the pointer is set to the head of a header for a next process method. Then, processing returns to step S241.

If equal at step S242, processing proceeds to step S244. A pointer is set to the head address of data for process of Fig. 19. Then, processing proceeds to step S245.

At step S245, a CMM process is executed to make conversion to data dependent on printer characteristics using data for process pointed by the pointer. Then, processing terminates.

That is, as in the first embodiment, according to the process described above, at steps S200 to S203, each piece of information is set for executing CMM designated by the user from the console unit 2c. At steps S204 to S224, a scanner related process is executed, and at steps S225 to S245, a printer related process is executed.

Thus, when a certain type of CMM and a CMM process are designated, information for the designated

type of CMM and process is fetched from device profiles associated with devices concerned (scanner and printer profiles in this example). Based on the information, a color matching process can be executed.

Processes of step S115 of Fig. 11, step S127 of Fig. 13, step S224 of Fig. 23, and step S245 of Fig. 26 are designated ones out of a plurality of processes to realize a designated type of CMM.

As described above, according to the first and second embodiments, it is possible to execute a color matching process according to characteristics of input image data and user's applications.

As in the case of CMM, information used for a gamut check, which determines whether input image data falls in the color gamut of an output device, may be made selectable according to applications and functions.

That is, the correspondence of a gamut type in a header of a profile and information corresponding to the gamut type with speed or accuracy may be established.

An example of a process where color matching is rather lower in accuracy, but shorter in processing time, and an example of a process where color matching is higher in accuracy, but longer in processing time, will be given as examples of color matching processes corresponding to combinations of CMMSubtype and CMprocesstype in the first and second embodiments described above.

(Example of a process where color matching is rather lower in accuracy, but shorter in processing time)

Fig. 27 shows an example of the process of step S115 of Fig. 11 or step S224 of Fig. 23, i.e. an example of a process of converting input data dependent on characteristics of a source device to standard data.

Here, scanner dependent RGB brightness data is converted to device independent XYZ data provided for by CIE (International Commission on Illumination).

Since the scanner dependent RGB data is the one defined colorimetrically (a chromaticity value is definite for R, G, B and white), the relational expression of Fig. 29 holds between the RGB data and XYZ data. The relational expression of Fig. 29 can be used for the process of step S115 of Fig. 11.

Where, P_{ij} (i, j = 1, 2, 3) indicates constants determined respectively by colorimetric definitions of RGB dependent on the scanner 4. The constant can be used as data for CMM process of step S114 of Fig. 11 or step S223 of Fig. 23.

Fig. 28 shows an example of the process of step S127 of Fig. 13 or step S245 of Fig. 26, i.e. an example of a process of converting the standard data to data dependent on output characteristics of a destination device.

At step S30, the XYZ data converted at step S20 of Fig. 27 is converted to RGB data conforming to NTSC (National Television System Committee). Then, processing proceeds to step S31.

At step S31, the above RGB data conforming to NTSC is converted to printer dependent CMYK data. Then, processing terminates.

Since the RGB data conforming to NTSC is the one defined colorimetrically (a chromaticity value is definite for R, G, B and white), the relational expression of Fig. 30 holds between the RGB data and XYZ data. The relational expression of Fig. 30 can be used for the process of step S30 of Fig. 28.

Where, q_{ij} (i, j = 1, 2, 3) indicates constants determined respectively by colorimetric definitions of RGB conforming to NTSC.

Fig. 31 shows an example of the process of step S31 of Fig. 28.

At process 1, a process of density conversion is executed to execute LOG conversion on brightness information of R, G and B values for conversion to density information of C, M and Y values.

At process 2, a process of under color removal is executed to take a Bk value out of the C, M and Y values.

At process 3, a process of masking is executed to make correction for unwanted absorption characteristics of C, M and Y toner or ink and to execute color matching.

At process 4, a process of gamma conversion is executed to adjust contrast and brightness according to an image.

Fig. 32 shows an example of a table used at process 1 described above.

Density information of C, M and Y values (0 to 255) can be easily obtained for input brightness information of R, G and B values (0 to 255).

Fig. 33 shows an example of a table used at process 4 described above.

Output C, M, Y and K values (0 to 255) can be easily obtained for input C, M, Y and K values (0 to 255).

Fig. 34 shows an example of a process of process 3 described above.

Where, r_{ij} (i, j = 1, 2, 3) is a constant whose value varies depending on the type of CMM.

A processing speed can be improved by having the results of addition of parts enclosed with a dotted line in Fig. 34, in the form of a table.

Data in this table can be used as data for CMM process at step S126 of Fig. 13 or data for process at step S244 of Fig. 26. That is, a color matching process including color gamut compression can be executed at a high speed using a matrix operation.

(Example of a process where color matching is higher in accuracy, but longer in processing time)

An example of the process of step S115 of Fig. 11 or step S224 of Fig. 23 is identical to the process of Fig. 27 described above.

Fig. 35 shows an example of the process of step S127 of Fig. 13 or step S245 of Fig. 26.

At step S40, the XYZ data converted at step S20 of Fig. 27 is converted to L*a*b* data. Then, processing proceeds to step S41.

At step S41, the above L*a*b* data is converted to printer dependent CMYK data, and then processing terminates.

Fig. 36 shows an example of the process of step S40 of Fig. 35.

Where, Xn, Yn and Zn are constants determined by which standard light source provided for by CIE to conform to.

Step S41 of Fig. 35 executes a process of converting L*a*b* including colors falling outside the color gamut of a printer to CMYK falling in the color gamut of the printer by means of color gamut compression.

There is a method for realizing this color gamut compression process which uses three-dimensional LUT (look-up table).

Fig. 38 shows an example of LUT.

LUT is in such a three-dimensional table structure that a three-dimensional color solid of L*a*b* is divided equally spaced (ΔL^*, Δa^*, Δb^*) in the direction of each coordinate axis and in the form of lattice. A value of CMYK corresponding to a sampled value of L*a*b* is stored at each vertex of each solid of lattice.

If the type of CMM is different, the above value of CMYK corresponding to a sampled value of L*a*b* is also different, and hence a value in the table described above becomes different accordingly.

Fig. 39 is an enlarged view exemplifying one solid of lattice containing an input L*a*b* value to LUT.

Here, a z direction corresponds to an L* axis, an x direction to an a* axis, and a y direction to a b* axis.

Let an input L*a*b* value be positioned at point P.

Take a vertex at near left of lattice as (x_1, y_1, z_1), suppose $\Delta L^* = \Delta a^* = \Delta b^* = 1$, and take a displacement from the vertex to point P as x_f, y_f, z_f. Then, coordinates and relation shown in Fig. 6 will hold.

If a value of CMYK stored at each vertex is expressed by U (x, y, z), then a value of CMY stored at point P, U ($x_1 + x_f$, $y_1 + y_f$, $z_1 + z_f$), can be obtained by interpolation expressed by the following.

$$
\begin{aligned}
& U(x_1 + x_f,\ y_1 + y_f,\ z_1 + z_f) \\
&= U(x_1,\ y_1,\ z_1) \cdot (1 - x_f)(1 - y_f)(1 - z_f) \\
&\quad + U(x_1 + 1,\ y_1,\ z_1) \cdot x_f (1 - y_f)(1 - z_f) \\
&\quad + U(x_1,\ y_1 + 1,\ z_1) \cdot (1 - x_f)\, y_f (1 - z_f) \\
&\quad + U(x_1,\ y_1,\ z_1 + 1) \cdot (1 - x_f)(1 - y_f)\, z_f \\
&\quad + U(x_1,\ y_1 + 1,\ z_1 + 1) \cdot (1 - x_f)\, y_f\, z_f \\
&\quad + U(x_1 + 1,\ y_1,\ z_1 + 1) \cdot x_f (1 - y_f)\, z_f \\
&\quad + U(x_1 + 1,\ y_1 + 1,\ z_1) \cdot x_f\, y_f (1 - z_f) \\
&\quad + U(x_1 + 1,\ y_1 + 1,\ z_1 + 1) \cdot x_f\, y_f\, z_f
\end{aligned}
$$

Thus, a value of CMY corresponding to the input L*a*b* value can be obtained using LUT and an interpolation process.

The abovementioned method using LUT can realize highly accurate matching, but has a drawback that processing time becomes longer due to the interpolation process involved.

Thus, a highly accurate color gamut check can be executed.

The construction described above allows the user to select CMM according to an application for image processing.

When a plurality of CMMs are different in accuracy as in the embodiment described above, the user can

designate CMM based on an accuracy.

A feature of CMM is not limited to accuracy. For example, time required for processing or the like may be acceptable as a feature of CMM.

The present invention is not limited to a conversion process from scanner color space to printer color space, but may be applicable to combinations of other color spaces such as a conversion process from scanner color space to monitor color space and the like.

An "example of a process where color matching is rather lower in accuracy, but shorter in processing time" and an "example of a process where color matching is higher in accuracy, but longer in processing time" are not limited to the processes described above. For example, combinations of other processes such as the abovementioned color gamut compression by primary masking, color gamut compression by secondary masking and the like may be acceptable.

(Third embodiment)

The present embodiment relates to an example of a process to be executed in a case where when a device profile having information used for a process of a designated color matching method is selected as a source profile for executing a matching process based on the designated color matching method, the destination profile having information used for the process of the designated color matching method does not exist.

Fig. 42 shows the structure of the header information unit. Here, the header information unit stores a device model, a data size, a version, CMMSubtype, Gamutchecktype, an offset value for the CMM process information storage unit, and an offset value for the information storage unit for device color gamut check.

The structure of a profile and the structure of the CMM process information storage unit are similar to those for the first embodiment.

Figs. 43 to 45 show flow charts illustrating a process of selecting a destination file based on a color matching method described in a source profile for image data and of executing color matching at the color reproduction process unit 2a.

At step S500, image data is read. Then, processing proceeds to step S501.

At step S501, whether a device profile is attached to the image data is checked.

If the profile is attached, processing proceeds to step S502, and the attached profile is set for a source profile. Then, processing proceeds to step S504.

If the profile is not attached, processing proceeds to step S503, and a system profile is set for a source profile. Then, processing proceeds to step S504.

Here, the system profile denotes one of color monitor profiles which are currently held for use. The system profile may be designated by the user or other method, for example, by such a method that an application automatically designates the system profile according to a printing speed of a color output device.

At step S504, a pointer is set to the head of the source profile. Then, processing proceeds to step S505.

At step S505, the contents of CMMSubtype which have been fetched from the header information unit of Fig. 11 based on the head address of a profile pointed by the pointer are set for CMMtype. Then, processing proceeds to step S506.

At step S506, the device model information of a printer in use is set for pmodel. Then, processing proceeds to step S507.

At step S507, a pointer is set to the head of a profile address table. Then, processing proceeds to step S508.

At step S508, 1 is set for constant I. Then, processing proceeds to step S508.

At step S509, the value of i and the value of m (constant) indicative of the number of profiles are compared.

If i is greater than m, processing proceeds to step S510 to notify the user of the absence of a profile necessary for a designated process.

At step S511, an instruction from the user whether to use a default printer profile for processing is waited for.

If an instruction to terminate processing is given, processing terminates.

If it is indicated that the user uses a default printer profile for processing, processing proceeds to step S512, and a previously prepared default printer profile is set for a destination profile. Then, processing proceeds to step S513.

Here, the default printer profile is a printer profile having information for a process of a default CMM.

If i is not greater than m, processing proceeds to step S513. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with smodel.

If not equal, processing proceeds to step S515. i and the pointer are incremented by one, and then proc-

essing returns to step S509.

If equal at step S513, processing proceeds to step S514. CMMsubtype which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S515. i and the pointer are incremented by one, and then processing returns to step S509.

If equal at step S514, processing proceeds to step S516. A printer profile pointed by a pointer is set for a destination profile, and then processing proceeds to step S517.

At step S517, a CMM process is executed. Then, processing proceeds to step S518.

At step S518, whether remaining image data exists is checked. If not, processing terminates. If present, processing returns to step S500.

Thus, even when an independent printer profile having information corresponding to a designated type of CMM does not exist, a previously prepared printer profile corresponding to a default CMM is selected as a destination profile for executing a color matching process.

Figs. 46 and 47 show flow charts illustrating the process of step S517 of Fig. 45.

At step S600, the head address of a source profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S601.

At step S601, an offset value for the CMM process information storage unit in the header information unit is set for adr2. Then, processing proceeds to step S602.

At step S602, pointer1 is set to adr1 + adr2. Then, processing proceeds to step S603.

At step S603, pointer1 is set to the head of data for CMM process in the CMM process information storage unit. Then, processing proceeds to step S604.

At step S604, the head address of a destination profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S605.

At step S605, an offset value for the CMM process information storage unit in the header information unit is set for adr2. Then, processing proceeds to step S606.

At step S606, pointer2 is set to adr1 + adr2. Then, processing proceeds to step S607.

At step S607, pointer2 is set to the head of data for CMM process in the CMM process information storage unit. Then, processing proceeds to step S608.

At step S608, a CMM process is executed using data for CMM process pointed by pointer1 and pointer2, and then processing terminates.

Thus, a color matching process can be executed using information for CMM process of a designated source profile and of a selected destination profile.

If information for a designated process does not exist, the user will be notified of it and hence be able to recognize whether a process wanted by the user is executable or not. Processing can be continued or terminated as desired by the user.

In the example given above, a printer profile is taken up as a destination profile. However, a similar process is also applicable, for example, to a monitor profile or the like.

At step S704, a pointer is set to the head of the source profile. Then, processing proceeds to step S705.

At step S705, information about a designated type of CMM is set for CMMtype. Then, processing proceeds to step S706.

At step S706, the device model information of a printer in use is set for pmodel. Then, processing proceeds to step S707.

At step S707, a pointer is set to the head of a profile address table. Then, processing proceeds to step S708.

At step S708, 1 is set for constant i. Then, processing proceeds to step S709.

At step S709, the value of i and the value of m (constant) indicative of the number of profiles are compared. If i is greater than m, processing terminates.

If not, processing proceeds to step S710. Information about a device model which has been fetched from the header information unit based on the head address of a profile pointed by a pointer is compared with pmodel.

If not equal, processing proceeds to step S711. i and the pointer are incremented by one, and then processing returns to step S709.

If equal at step S712, a printer profile pointed by a pointer is set for a destination profile, and then processing proceeds to step S713.

(Fourth embodiment)

The present embodiment relates to an example of a process of executing color matching on color image

data in a case where when a device profile having information used for a process of a designated color matching method is selected for executing a matching process based on the designated color matching method, information used for the process of the designated color matching method does not exist in a source profile or a destination profile.

The structure of a profile, the structure of the header information unit, the structure of the CMM process information storage unit, and the structure of the data storage unit for CMM are similar to those for the second embodiment.

Figs. 48 to 50 show flow charts illustrating a process of fetching information used for a process of a designated color matching method from a source profile and a destination profile and of executing color matching at the color reproduction process unit 2a.

At step S700, image data is read. Then, processing proceeds to step S701.

At step S701, whether a device profile is attached to the image data is checked.

If the profile is attached, processing proceeds to step S702, and the attached profile is set for a source profile. Then, processing proceeds to step S704.

If the profile is not attached, processing proceeds to step S703, and a system profile is set for a source profile. Then, processing proceeds to step S704.

Here, the system profile denotes a color monitor profile in current use.

At step S713, a CMM process is executed. Then, processing proceeds to step S714.

At step S714, whether remaining image data exists is checked. If not, processing terminates. If present, processing returns to step S700.

Figs. 51 to 53 show a flow chart illustrating the process of step S713 of Fig. 50.

At step S800, the head address of a source profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S801.

At step S801, an offset value for the CMM process information storage unit in the header information unit is set for adr2. Then, processing proceeds to step S802.

At step S802, pointer1 is set to adr1 + adr2. Then, processing proceeds to step S803.

At step S803, pointer1 is set to the head of header for CMM1 in the CMM process information storage unit. Then, processing proceeds to step S804.

At step S804, 1 is set for constant j. Then, processing proceeds to step S805.

At step S805, the value of j and the value of n (constant) indicative of the number of profiles are compared.

If j is greater than n, processing proceeds to step S806 to notify the user of the absence of information necessary for a designated process.

At step S807, an instruction from the user whether to use a default printer profile for processing is waited for.

If an instruction to terminate processing is given, processing terminates.

If it is indicated that the user uses a default printer profile for processing, processing proceeds to step S808, and pointer1 is set to the head of header for a default CMM. Then, processing proceeds to step S811.

Here, the default CMM is a CMM predetermined as default, i.e. one of n types of CMMs.

If j is not greater than n, processing proceeds to step S809. CMMsubtype which has been fetched from the header for CMM pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S810. j is incremented by one, and the pointer is set to the head of header for a next CMM. Then, processing returns to step S805.

If equal at step S809, pointer1 is set to the head address of CMM data for CMM pointed by a pointer. Then, processing proceeds to step S516.

At step S811, pointer1 is set to the head address of data for CMM. Then, processing proceeds to step S812.

At step S812, the head address of a destination profile is fetched, and the fetched head address is set for adr1. Then, processing proceeds to step S813.

At step S813, an offset value for the CMM process information storage unit in the header information unit is set for adr2. Then, processing proceeds to step S814.

At step S814, pointer2 is set to adr1 + adr2. Then, processing proceeds to step S815.

At step S815, pointer2 is set to the head of header for CMM1. Then, processing proceeds to step S414.

At step S816, 1 is set for constant j. Then, processing proceeds to step S817.

At step S817, the value of j and the value of n (constant) indicative of the number of profiles are compared.

If j is greater than n, processing proceeds to step S818. Pointer2 is set to the head of header for a default CMM. Then, processing proceeds to step S822.

Here, the default CMM is a CMM predetermined as default, i.e. one of n types of CMMs.

If j is not greater than n, processing proceeds to step S819. CMMSubtype which has been fetched from the header for CMM pointed by a pointer is compared with CMMtype.

If not equal, processing proceeds to step S820. j is incremented by one, and the pointer is set to the head of header for a next CMM. Then, processing returns to step S817.

If equal at step S819, processing proceeds to step S821. Pointer1 is set to the head address of CMM data for CMM pointed by a pointer. Then, processing proceeds to step S822.

At step S822, a CMM process is executed using data for CMM process pointed by pointer1 and pointer2, and then processing terminates.

Thus, even when information used for a process of a designated CMM does not exist in a source profile or a printer profile, a color matching process can be executed using a process information of a predetermined default CMM.

If information for a designated process does not exist, the user will be notified of it and hence be able to recognize whether a process wanted by the user is executable or not.

Processing can be continued or terminated as desired by the user.

The present invention may be carried out by software or hardware means.

In the example given above, a printer profile is taken up as a destination profile. However, a similar process is also applicable to a monitor profile.

As described above, according to the present invention, in a color management system or the like, the provision of a method for selecting a color matching process for image processing renders a color matching process selectable according to an application.

Also, even when information used for a designated color matching process does not exist, the color matching process can be executed using previously prepared information.

By checking to see if information used for a designated color matching process exists and notifying the user of the results of the check, the user can recognize whether the designated color matching process can be executed or not.

Also, the user can select a color matching process giving preference to accuracy or the one giving preference to speed. For example, the user may execute a color matching process giving preference to speed when the printing speed of a color output device is fast. Thus, it is possible to execute a color matching process more suited to an application.

Claims

1. An image processing apparatus, comprising:
   designating means for designating one of a plurality of processes of realizing a predetermined type of a color matching method; and
   selecting means for selecting information for use with the designated process; and
   said apparatus processing color image data using the selected information.

2. An image processing apparatus according to Claim 1, wherein said designating means allows a user to designate a desired process from a plurality of the processes, each having a feature.

3. An image processing apparatus according to Claim 2, wherein the feature is an accuracy of color matching.

4. An image processing apparatus according to Claim 1, wherein the information is stored in a plurality of device profiles corresponding to the processes of realizing the color matching method, respectively.

5. An image processing apparatus according to Claim 1, wherein the information is stored in a single device profile.

6. An image processing apparatus, comprising:
   designating means for designating a color matching process;
   said apparatus executing image processing based on the designated process,
   wherein if information for use with the designated process does not exist, the color matching process is executed using previously prepared information.

7. An image processing apparatus according to Claim 6, wherein said designating means allows a user to designate a desired process from a plurality of the processes, each having a feature.

8. An image processing apparatus according to Claim 7, wherein the feature is an accuracy of color match-

ing.

9. An image processing apparatus according to Claim 6, wherein the information is stored in a plurality of device profiles corresponding to the processes of realizing the color matching method, respectively.

10. An image processing apparatus according to Claim 6, wherein the information is stored in a single device profile.

11. An image processing apparatus, comprising:
input means for inputting color image data;
designating means for designating an arbitrary color matching process method from a plurality of color matching process methods having different accuracies; and
color processing means for executing a color matching process based on the designated color matching method.

12. An image processing apparatus, comprising:
input means for inputting color image data;
designating means for designating an arbitrary color matching process method from a plurality of color matching process methods having different processing speeds; and
color processing means for executing a color matching process based on the designated color matching method.

13. An image processing apparatus, comprising:
storage means for storing information about a plurality of color matching process methods;
designating means for designating an arbitrary color matching process method from a plurality of the color matching process methods based on a type of a color matching process method and a process type; and
reading means for reading information about the designated color matching process method from said storage means.

14. An image processing method, comprising the steps of:
designating one of a plurality of processes of realizing a predetermined type of a color matching method;
storing information for use with the processes and selecting one of a plurality of the processes based on said designating means; and
processing color image data based on the selected process.

15. An image processing method for executing a designated color matching process wherein if information for use with the designated color matching process does not exist, the color matching process is executed using previously prepared information.

16. An image processing method, comprising the steps of:
designating one of a plurality of color matching processes;
checking for information for executing the designated process; and
notifying a user of the result of the check.

17. An image processing method, comprising the steps of:
generating information indicating which is selected, a color matching process giving preference to accuracy or a color matching process giving preference to speed; and
executing a color matching process based on the information in order to process given color image data.

18. An image processing method according to Claim 17, wherein the information is generated by designation of a user.

19. An image processing method according to Claim 17, wherein processed data is output to a color output device.

20. An image processing method according to Claim 19, wherein the information is automatically generated according to a speed of the color output device.

21. An image processing method, comprising the steps of:
inputting color image data;
designating an arbitrary color matching process method from a plurality of color matching process methods having different accuracies; and
executing a color matching process based on the designated color matching method for color processing.

22. An image processing method, comprising the steps of:
inputting color image data;
designating an arbitrary color matching process method from a plurality of color matching process methods having different processing speeds; and
executing a color matching process based on the designated color matching method for color processing.

23. An image processing method, , comprising the steps of:
storing information about a plurality of color matching process methods;
designating an arbitrary color matching process method from a plurality of the color matching process methods based on a type of a color matching process method and a process type; and
reading information about the designated color matching process method from said storing step.

24. A method of or apparatus for matching the colour gamut of colour image data from a source to the colour gamut of an output device in which there is stored a plurality of different colour matching processes any one of which can be selected.

FIG. 1

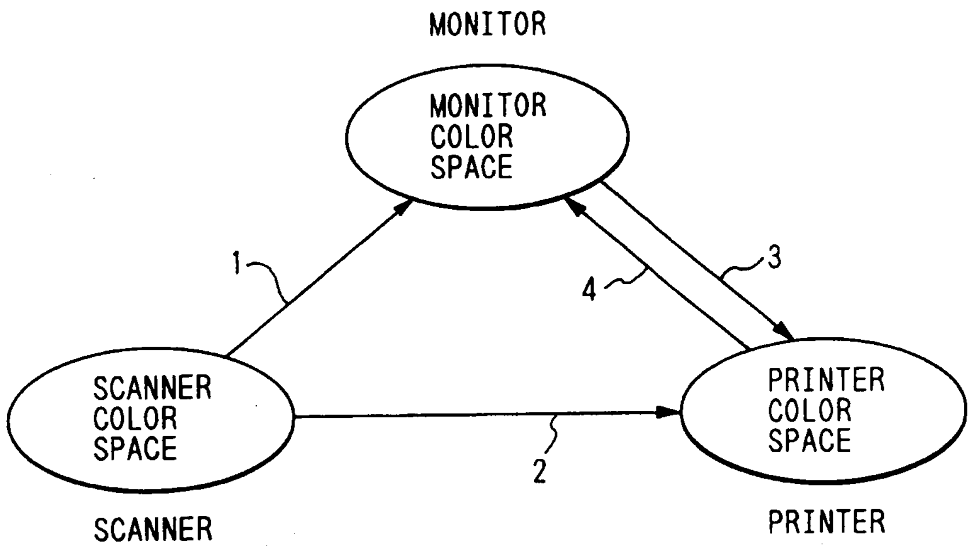

MONITOR
MONITOR COLOR SPACE
1
3
4
SCANNER COLOR SPACE
PRINTER COLOR SPACE
2
SCANNER
PRINTER

FIG. 3

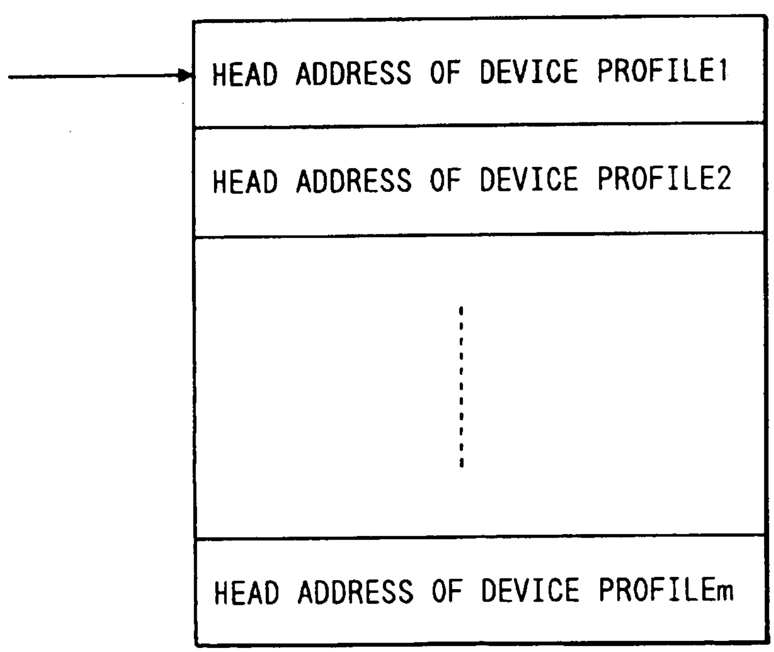

HEAD ADDRESS OF DEVICE PROFILE1
HEAD ADDRESS OF DEVICE PROFILE2
HEAD ADDRESS OF DEVICE PROFILEm

FIG. 2

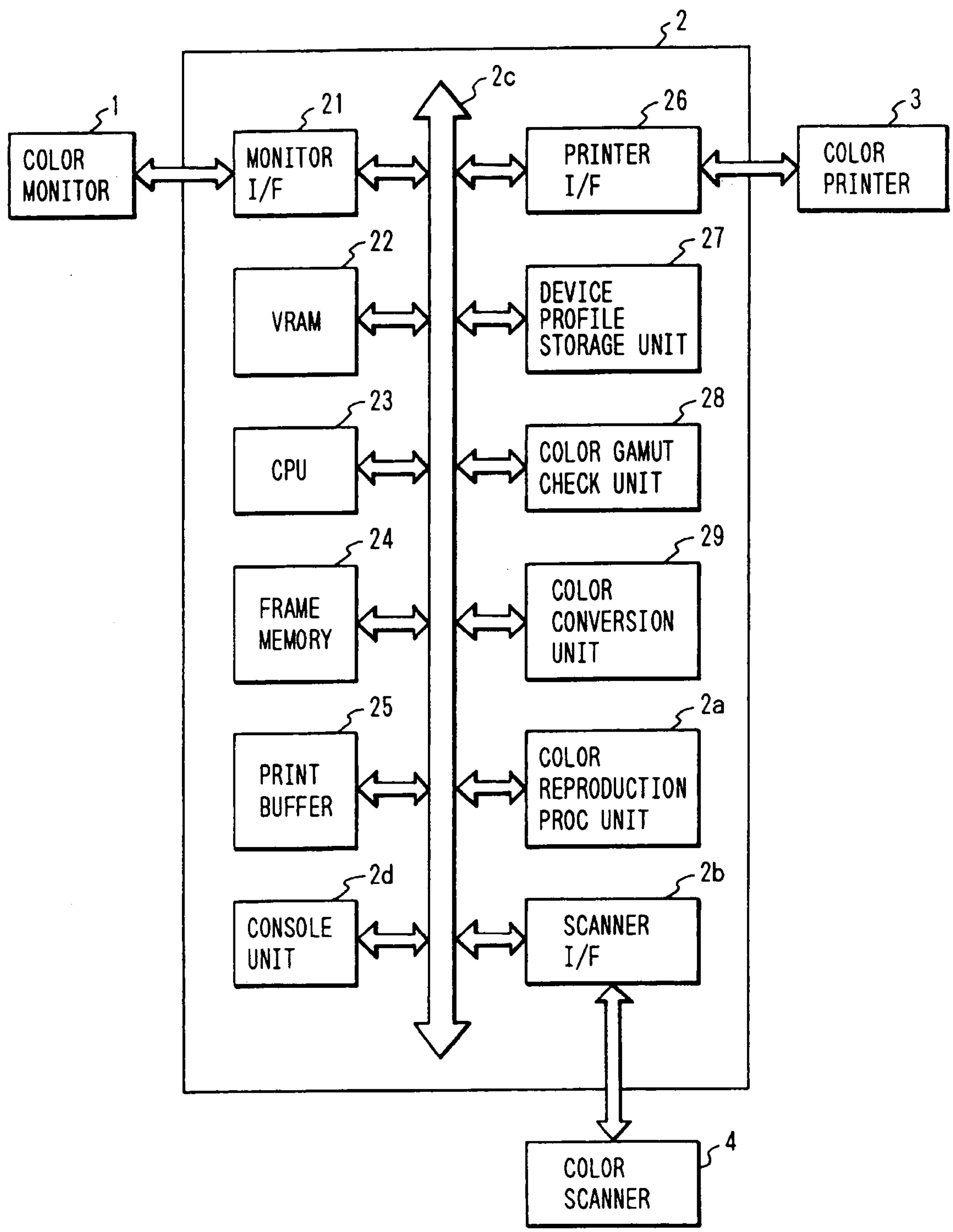

2
2c
1
COLOR MONITOR
21
MONITOR I/F
26
PRINTER I/F
3
COLOR PRINTER
22
VRAM
27
DEVICE PROFILE STORAGE UNIT
23
CPU
28
COLOR GAMUT CHECK UNIT
24
FRAME MEMORY
29
COLOR CONVERSION UNIT
25
PRINT BUFFER
2a
COLOR REPRODUCTION PROC UNIT
2d
CONSOLE UNIT
2b
SCANNER I/F
4
COLOR SCANNER

FIG. 4

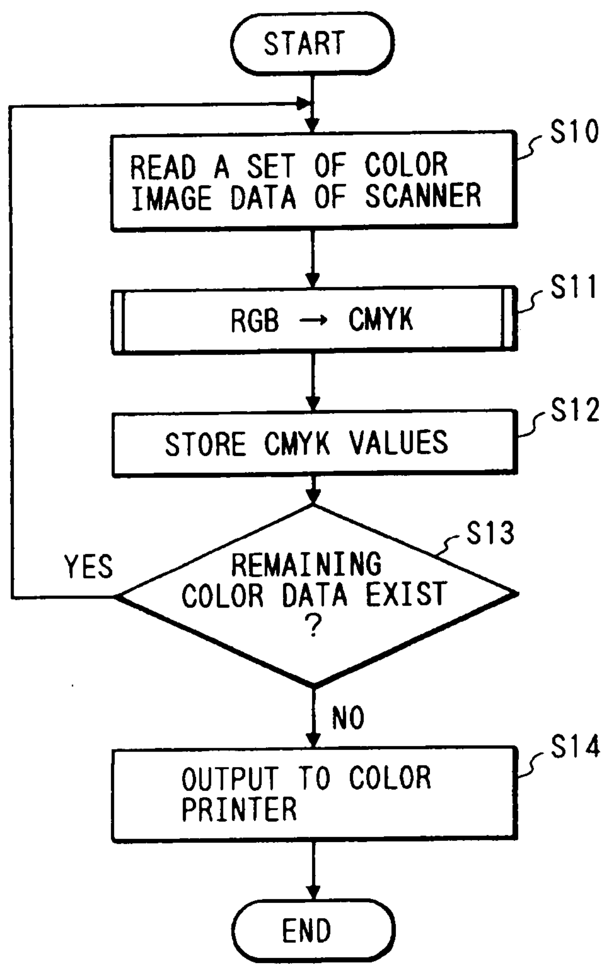

START
READ A SET OF COLOR IMAGE DATA OF SCANNER
S10
RGB → CMYK
S11
STORE CMYK VALUES
S12
REMAINING COLOR DATA EXIST ?
S13
YES
NO
OUTPUT TO COLOR PRINTER
S14
END

FIG. 5

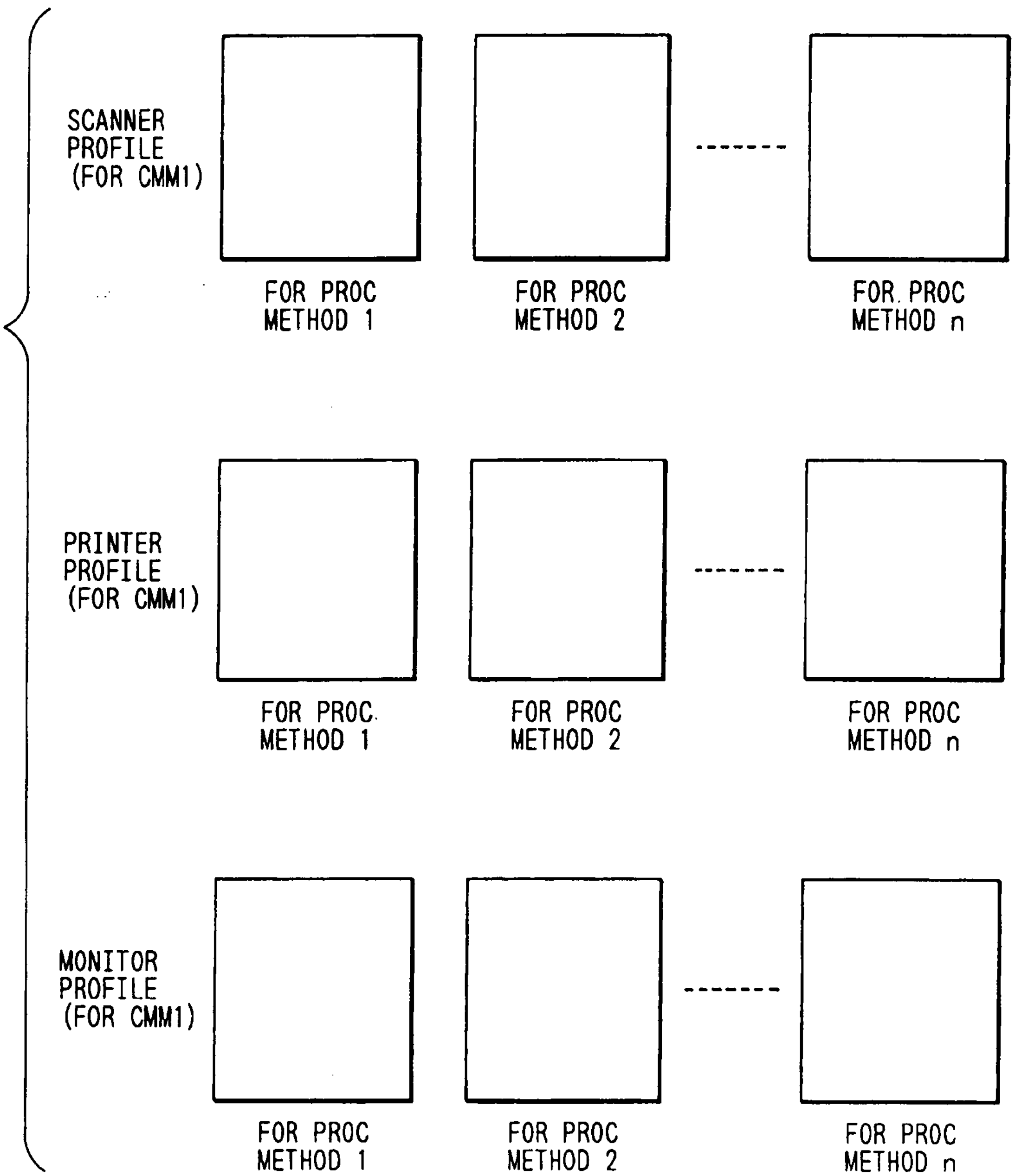

SCANNER
PROFILE
(FOR CMM1)
FOR PROC METHOD 1
FOR PROC METHOD 2
FOR PROC METHOD n
PRINTER
PROFILE
(FOR CMM1)
FOR PROC METHOD 1
FOR PROC METHOD 2
FOR PROC METHOD n
MONITOR
PROFILE
(FOR CMM1)
FOR PROC METHOD 1
FOR PROC METHOD 2
FOR PROC METHOD n

FIG. 6

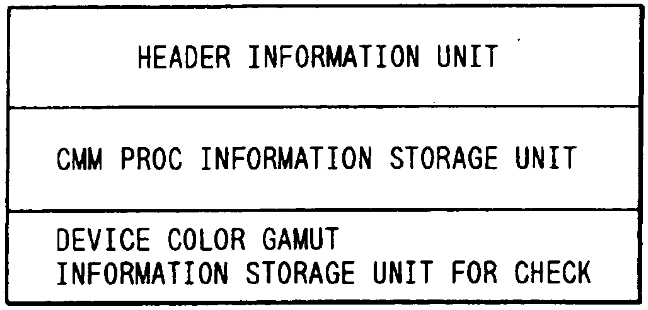


FIG. 7

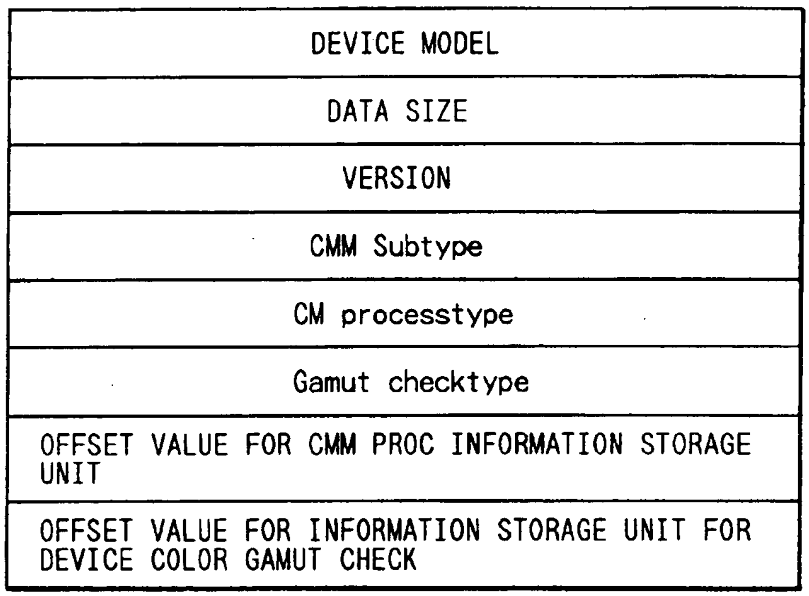


FIG. 8

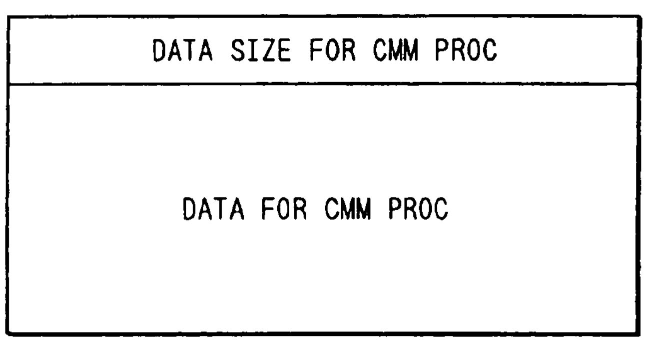


FIG. 9

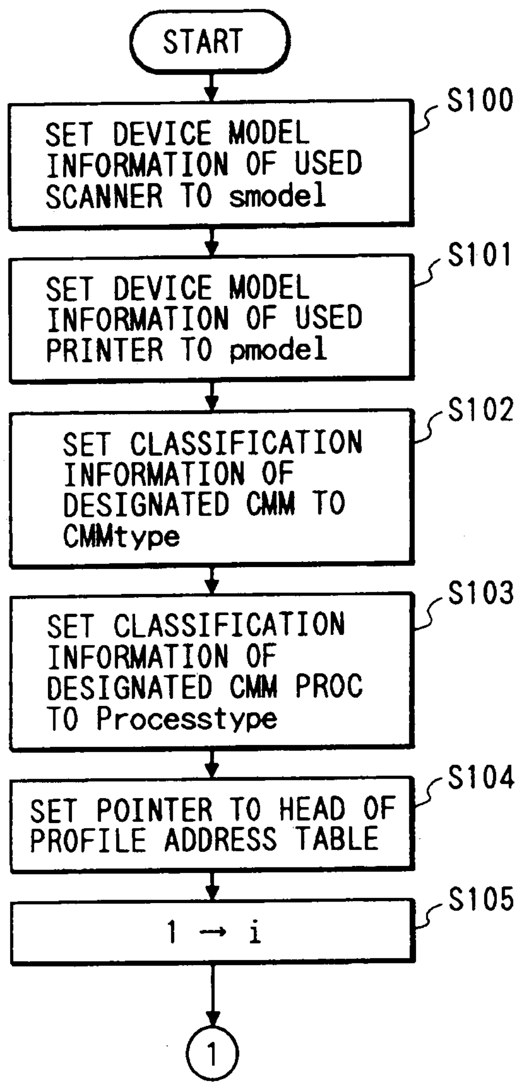

START
SET DEVICE MODEL INFORMATION OF USED SCANNER TO smodel
S100
SET DEVICE MODEL INFORMATION OF USED PRINTER TO pmodel
S101
SET CLASSIFICATION INFORMATION OF DESIGNATED CMM TO CMMtype
S102
SET CLASSIFICATION INFORMATION OF DESIGNATED CMM PROC TO Processtype
S103
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S104
1 → i
S105
1

FIG. 10

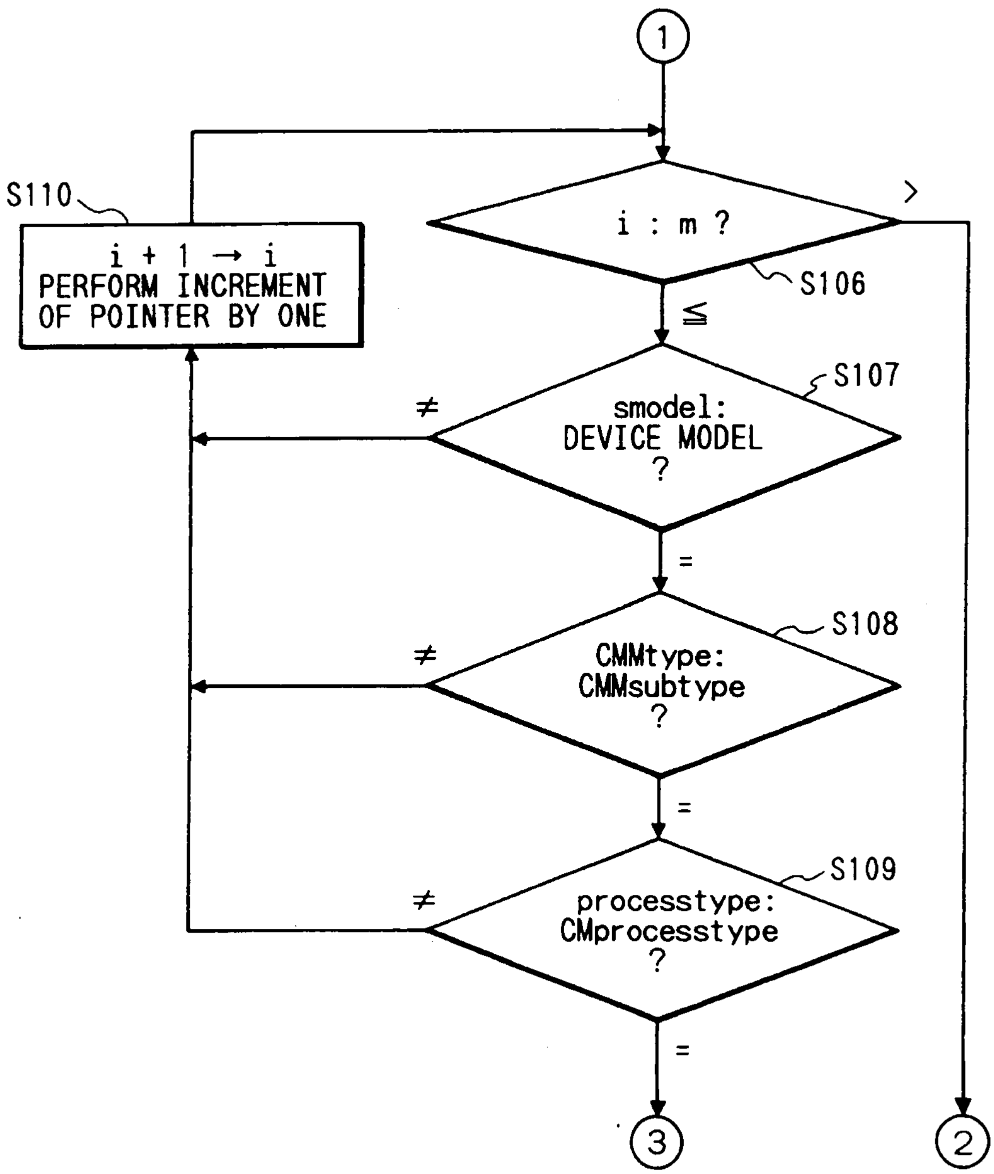

1
S110
i + 1 → i
PERFORM INCREMENT
OF POINTER BY ONE
i : m ?
>
S106
≦
S107
≠
smodel:
DEVICE MODEL
?
=
S108
≠
CMMtype:
CMMsubtype
?
=
S109
≠
processtype:
CMprocesstype
?
=
3
2

FIG. 11

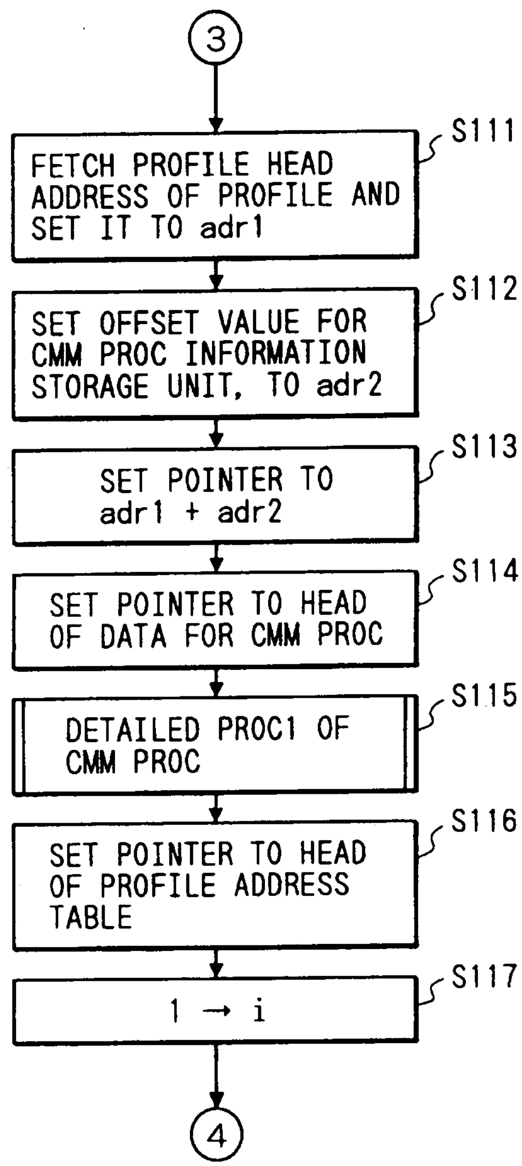

3
S111
FETCH PROFILE HEAD ADDRESS OF PROFILE AND SET IT TO adr1
S112
SET OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT, TO adr2
S113
SET POINTER TO adr1 + adr2
S114
SET POINTER TO HEAD OF DATA FOR CMM PROC
S115
DETAILED PROC1 OF CMM PROC
S116
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S117
1 → i
4

FIG. 12

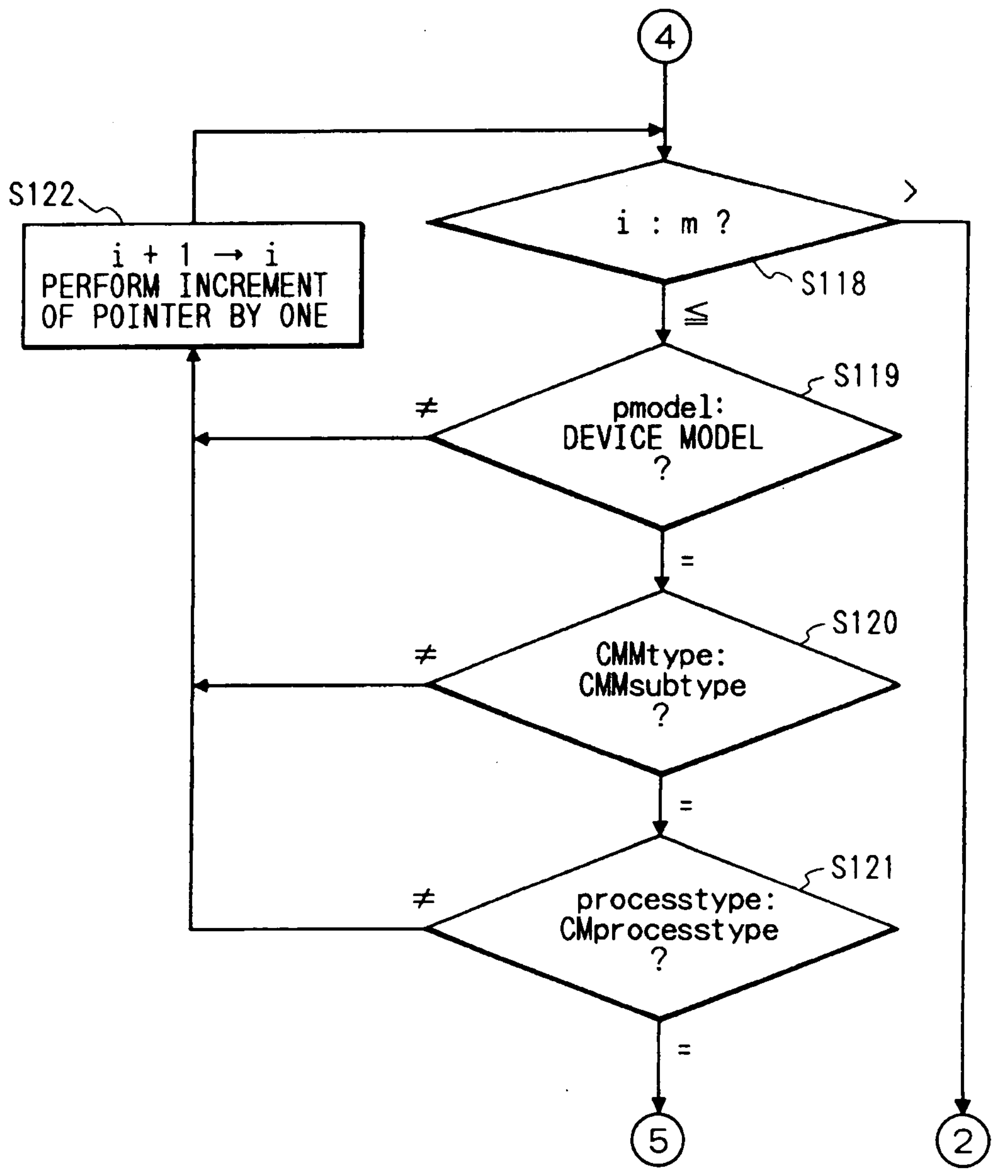

4
i : m ?
>
S118
≦
S122
i + 1 → i
PERFORM INCREMENT
OF POINTER BY ONE
S119
≠
pmodel:
DEVICE MODEL
?
=
S120
≠
CMMtype:
CMMsubtype
?
=
S121
≠
processtype:
CMprocesstype
?
=
5
2

FIG. 13

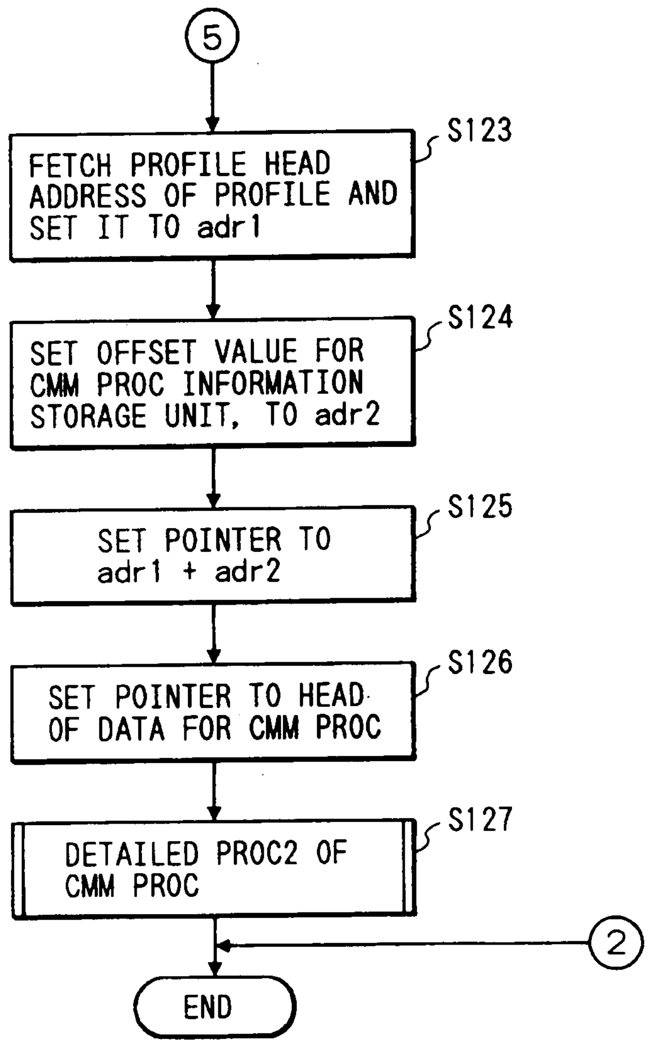

5
S123
FETCH PROFILE HEAD ADDRESS OF PROFILE AND SET IT TO adr1
S124
SET OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT, TO adr2
S125
SET POINTER TO adr1 + adr2
S126
SET POINTER TO HEAD OF DATA FOR CMM PROC
S127
DETAILED PROC2 OF CMM PROC
2
END

FIG. 14

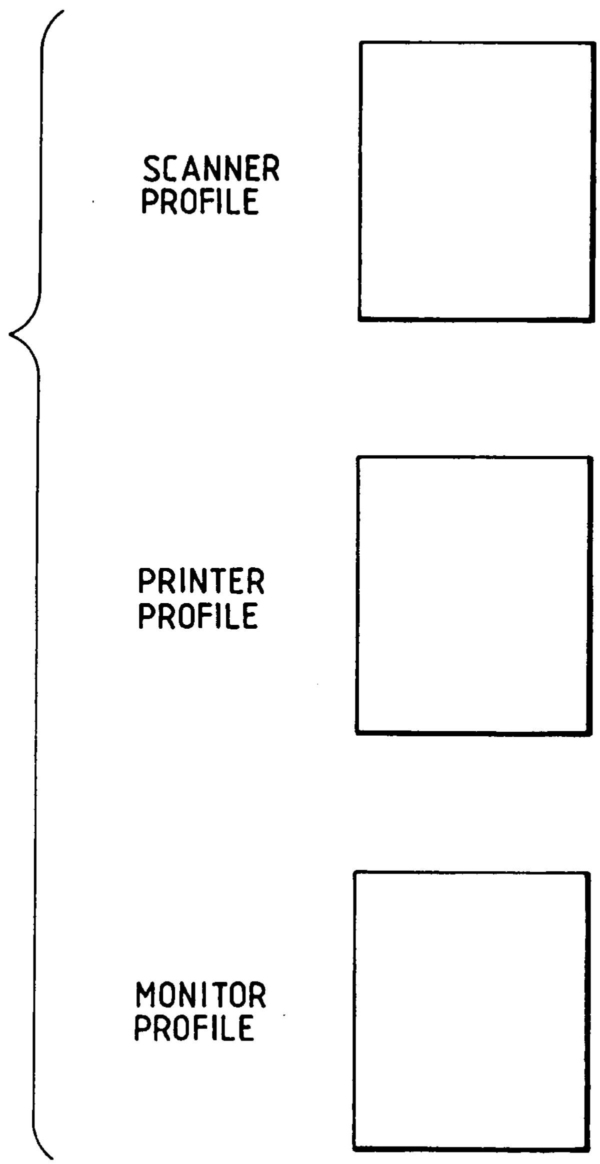


FIG. 15

DEVICE MODEL
DATA SIZE
VERSION
Gamut checktype
OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT
OFFSET VALUE FOR INFORMATION STORAGE UNIT FOR DEVICE COLOR GAMUT CHECK

FIG. 16

HEADER FOR CMM1
HEADER FOR CMM2
⋮
HEADER FOR CMMℓ
DATA FOR CMM1
DATA FOR CMM2
⋮
DATA FOR CMMℓ

FIG. 17

CMM Subtype
DATA SIZE FOR CMM
HEAD ADDRESS OF DATA FOR CMM

FIG. 18

HEADER FOR PROC METHOD1
HEADER FOR PROC METHOD2
⋮
HEADER FOR PROC METHODn
DATA FOR PROC METHOD1
DATA FOR PROC METHOD2
⋮
DATA FOR PROC METHODn

FIG. 19

CM processtype
SIZE OF DATA FOR PROC
HEAD ADDRESS OF DATA FOR PROC

FIG. 20

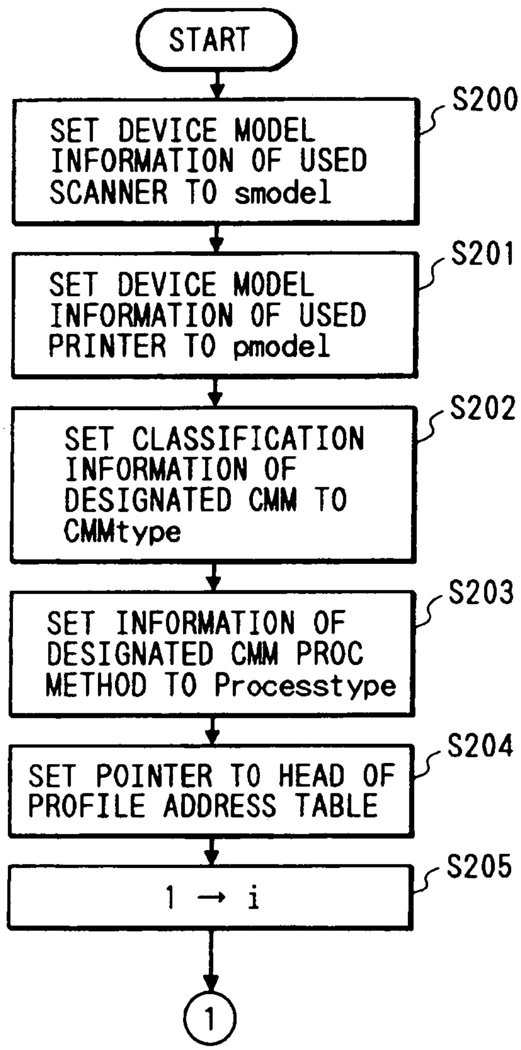

START
SET DEVICE MODEL INFORMATION OF USED SCANNER TO smodel
S200
SET DEVICE MODEL INFORMATION OF USED PRINTER TO pmodel
S201
SET CLASSIFICATION INFORMATION OF DESIGNATED CMM TO CMMtype
S202
SET INFORMATION OF DESIGNATED CMM PROC METHOD TO Processtype
S203
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S204
1 → i
S205
1

FIG. 21

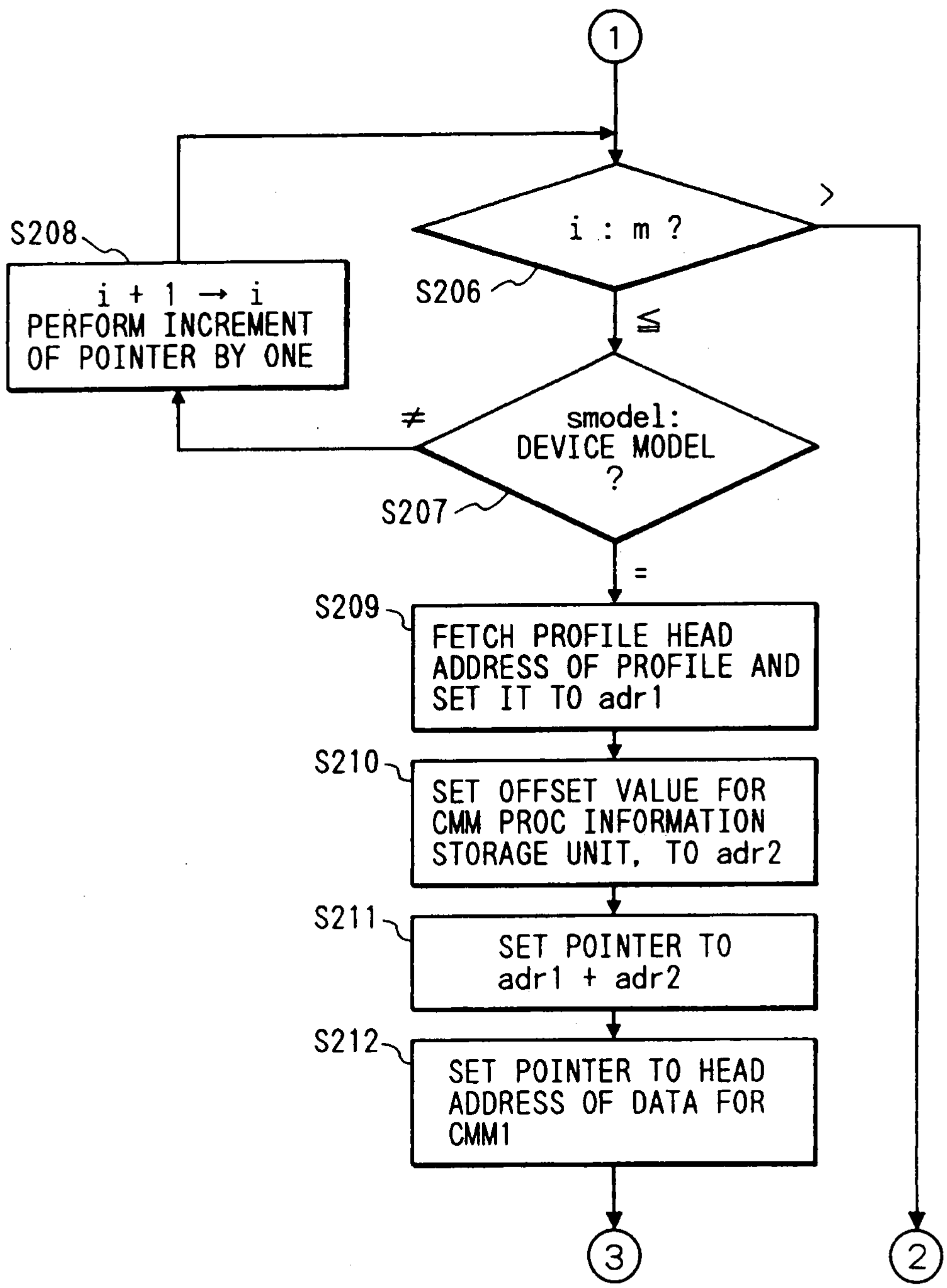

1
i : m ?
>
S206
≦
S208
i + 1 → i
PERFORM INCREMENT
OF POINTER BY ONE
≠
smodel:
DEVICE MODEL
?
S207
=
S209
FETCH PROFILE HEAD
ADDRESS OF PROFILE AND
SET IT TO adr1
S210
SET OFFSET VALUE FOR
CMM PROC INFORMATION
STORAGE UNIT, TO adr2
S211
SET POINTER TO
adr1 + adr2
S212
SET POINTER TO HEAD
ADDRESS OF DATA FOR
CMM1
3
2

FIG. 22

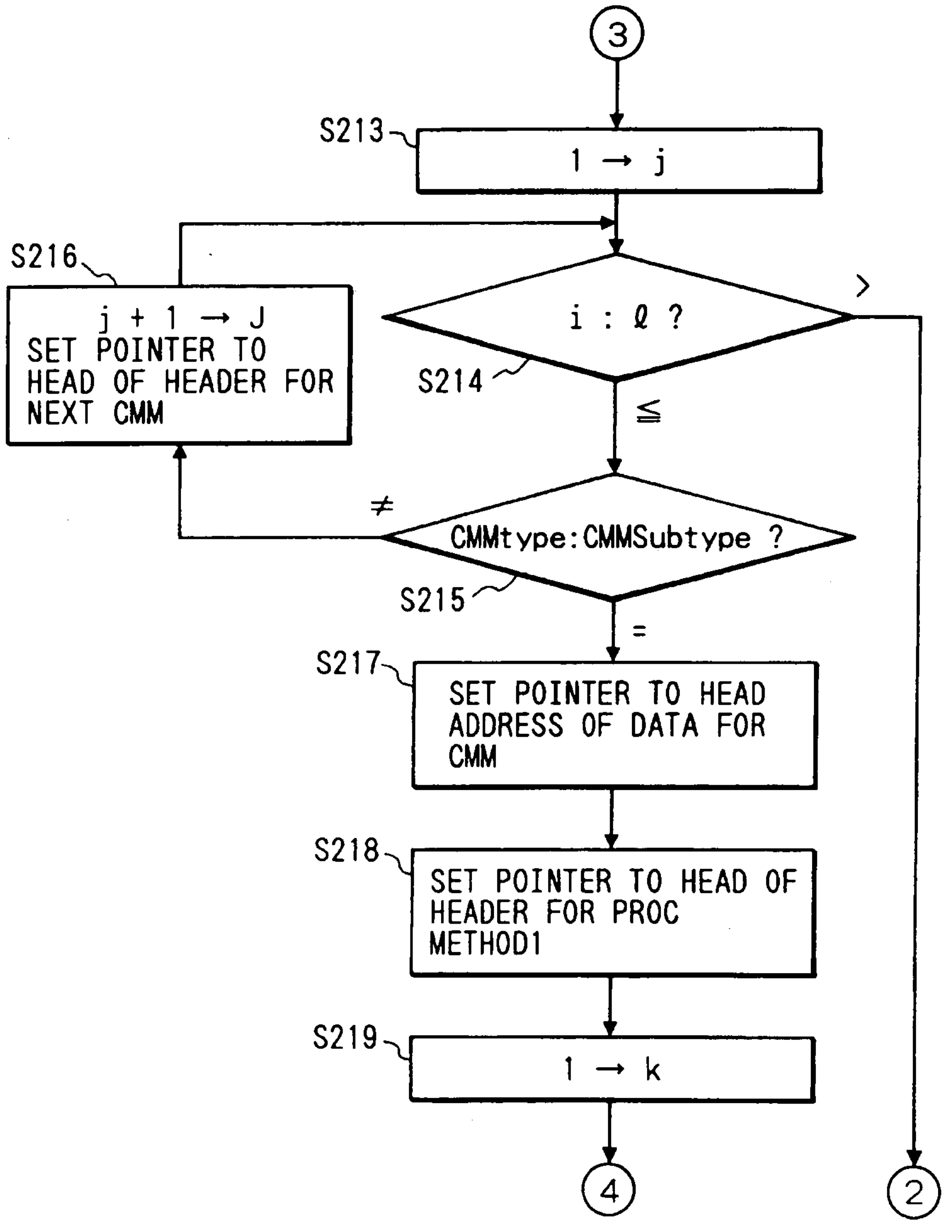

3
S213
1 → j
S216
j + 1 → J
SET POINTER TO
HEAD OF HEADER FOR
NEXT CMM
i : ℓ ?
S214
>
≦
≠
CMMtype:CMMSubtype ?
S215
=
S217
SET POINTER TO HEAD
ADDRESS OF DATA FOR
CMM
S218
SET POINTER TO HEAD OF
HEADER FOR PROC
METHOD1
S219
1 → k
4
2

FIG. 23

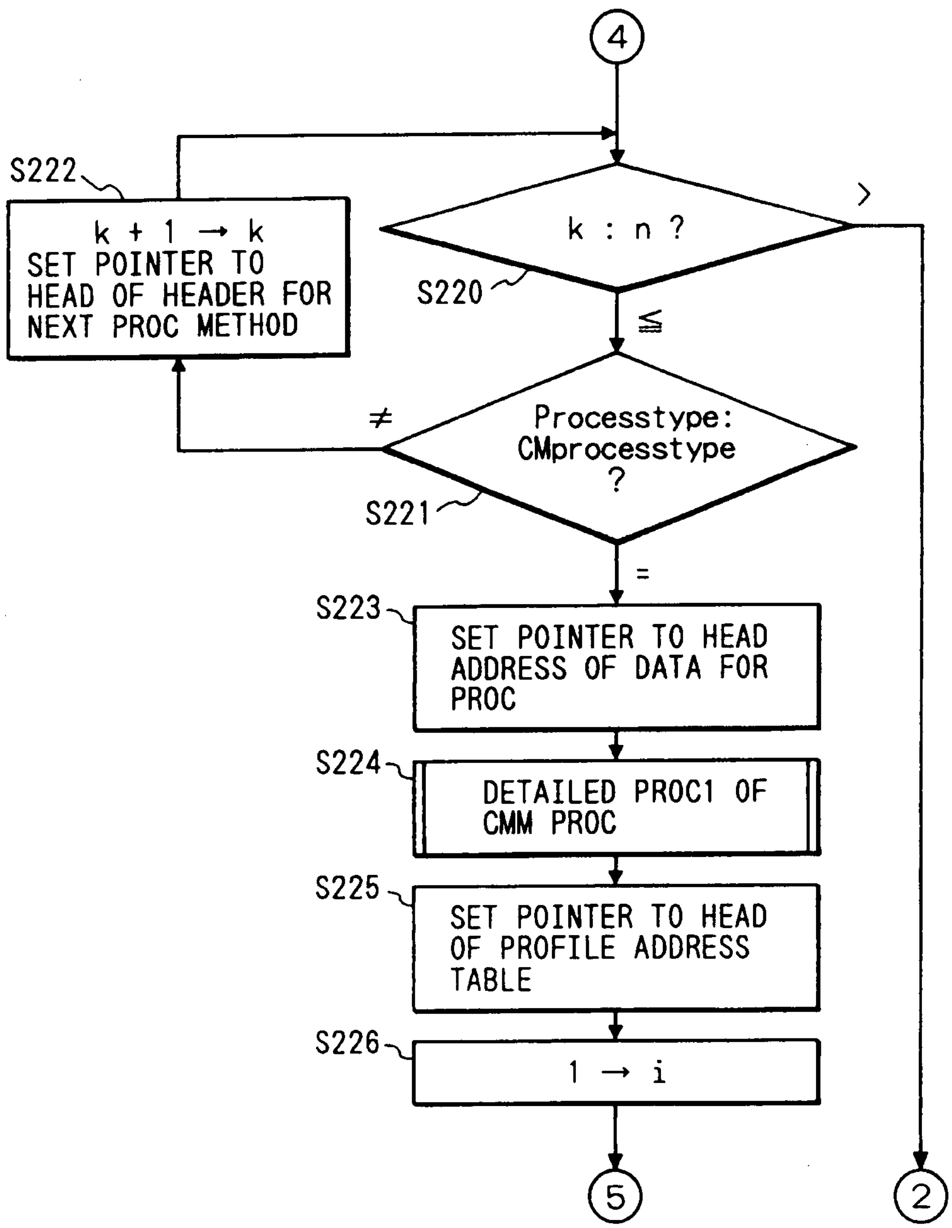

4
S222
k + 1 → k
SET POINTER TO HEAD OF HEADER FOR NEXT PROC METHOD
k : n ?
>
S220
≦
≠
Processtype: CMprocesstype ?
S221
=
S223
SET POINTER TO HEAD ADDRESS OF DATA FOR PROC
S224
DETAILED PROC1 OF CMM PROC
S225
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S226
1 → i
5
2

FIG. 24

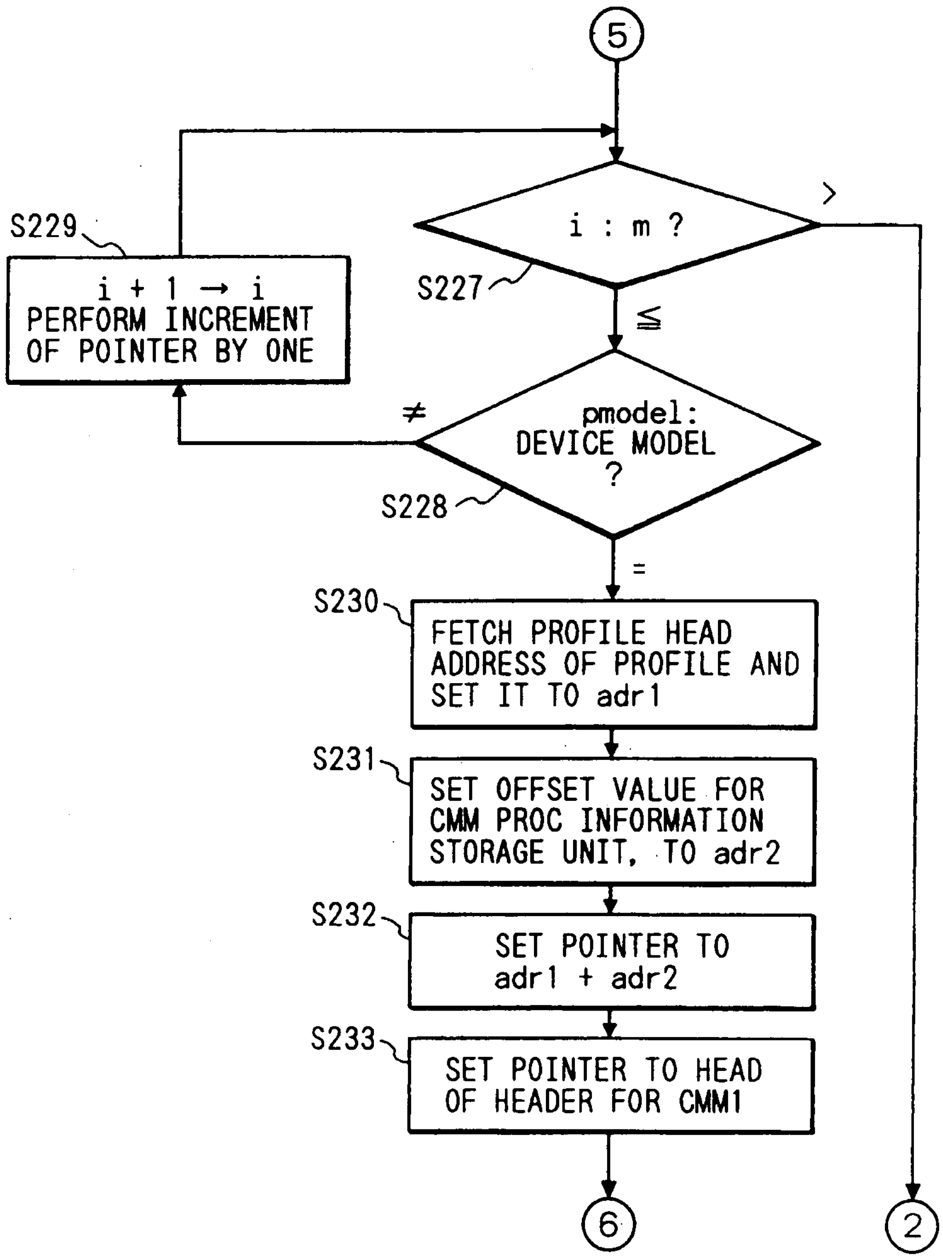

5
i : m ?
S227
>
≦
S229
i + 1 → i
PERFORM INCREMENT
OF POINTER BY ONE
≠
pmodel:
DEVICE MODEL
?
S228
=
S230
FETCH PROFILE HEAD
ADDRESS OF PROFILE AND
SET IT TO adr1
S231
SET OFFSET VALUE FOR
CMM PROC INFORMATION
STORAGE UNIT, TO adr2
S232
SET POINTER TO
adr1 + adr2
S233
SET POINTER TO HEAD
OF HEADER FOR CMM1
6
2

FIG. 25

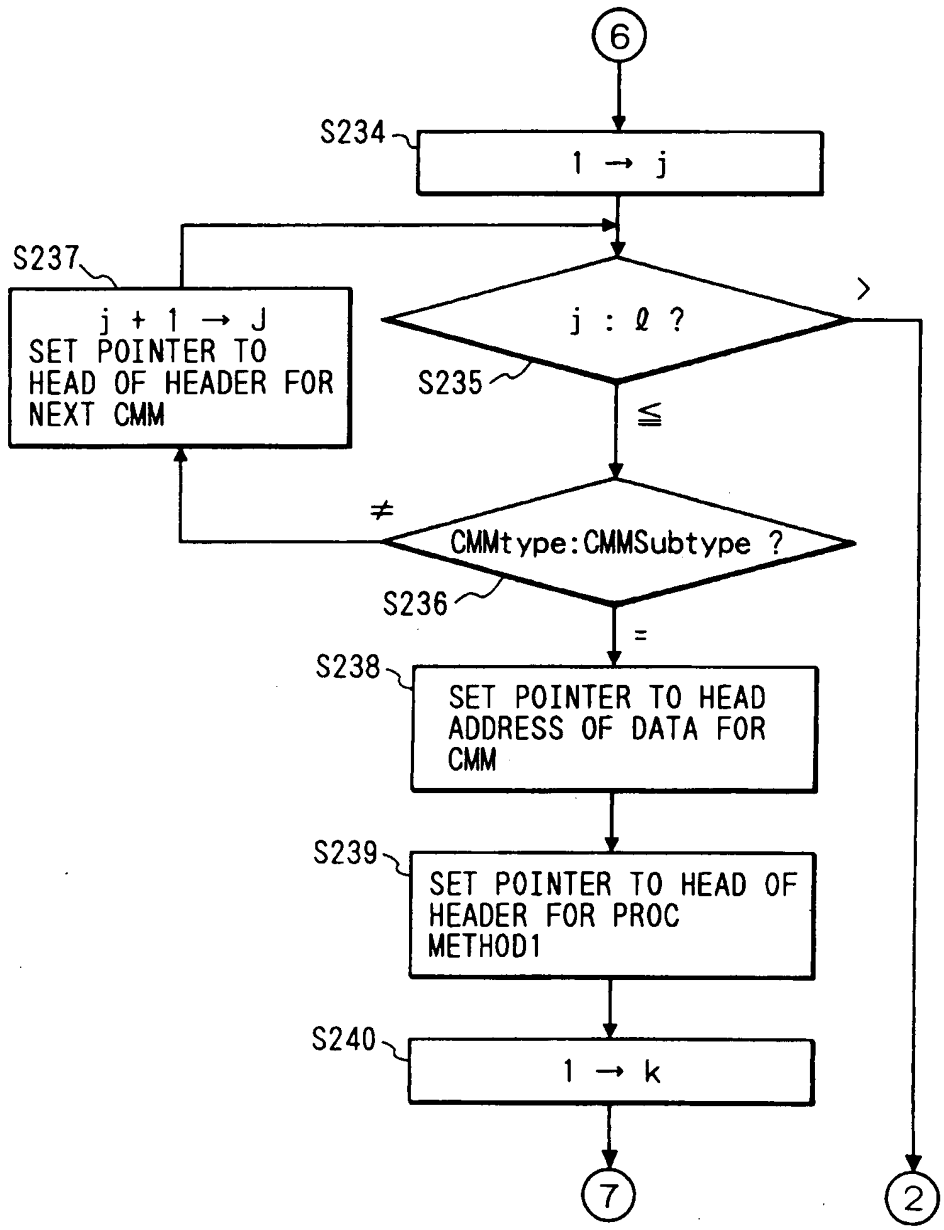

6
S234
1 → j
S237
j + 1 → J
SET POINTER TO HEAD OF HEADER FOR NEXT CMM
j : ℓ ?
>
S235
≦
≠
CMMtype:CMMSubtype ?
S236
=
S238
SET POINTER TO HEAD ADDRESS OF DATA FOR CMM
S239
SET POINTER TO HEAD OF HEADER FOR PROC METHOD1
S240
1 → k
7
2

FIG. 26

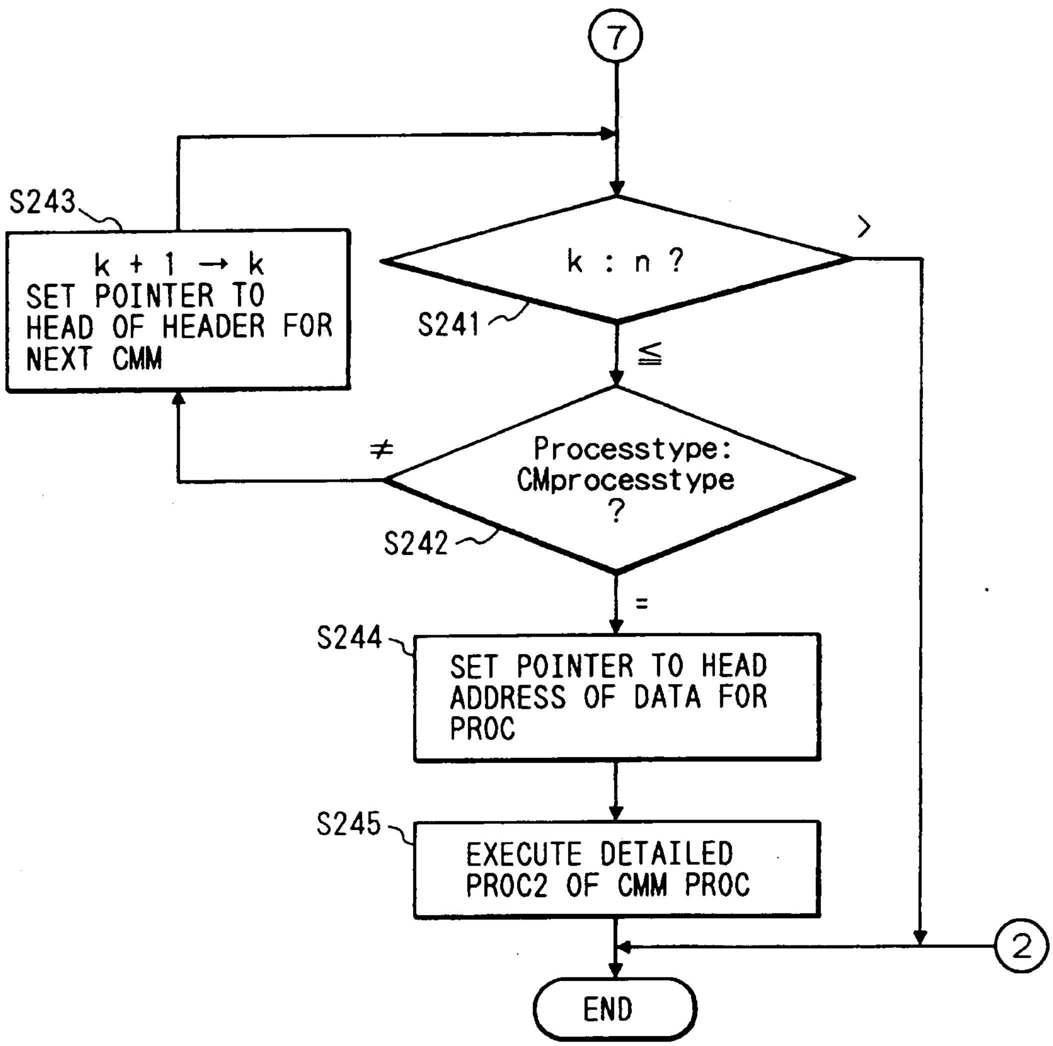

7
S243
k + 1 → k
SET POINTER TO
HEAD OF HEADER FOR
NEXT CMM
k : n ?
>
S241
≦
≠
Processtype:
CMprocesstype
?
S242
=
S244
SET POINTER TO HEAD
ADDRESS OF DATA FOR
PROC
S245
EXECUTE DETAILED
PROC2 OF CMM PROC
2
END

FIG. 27

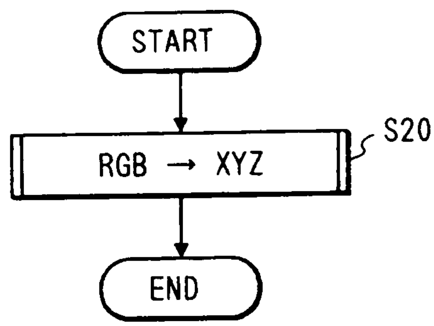

START
RGB → XYZ
S20
END

FIG. 28

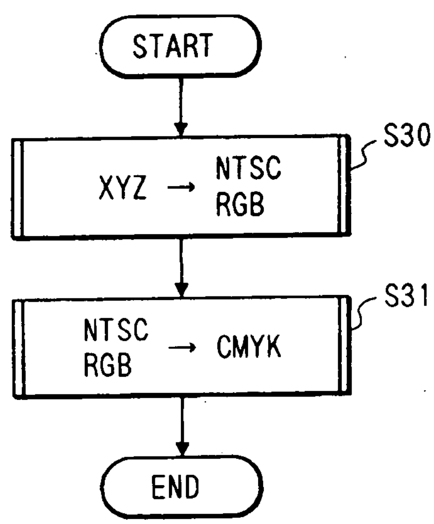

START
XYZ → NTSC RGB
S30
NTSC RGB → CMYK
S31
END

FIG. 29

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} P_{11} & P_{12} & P_{13} \\ P_{21} & P_{22} & P_{23} \\ P_{31} & P_{32} & P_{33} \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

FIG. 30

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} q_{11} & q_{12} & q_{13} \\ q_{21} & q_{22} & q_{23} \\ q_{31} & q_{32} & q_{33} \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

FIG. 34

$$\left\{ \begin{array}{l} \begin{pmatrix} C \\ M \\ Y \end{pmatrix} = \begin{pmatrix} Y_{11} & Y_{12} & Y_{13} \\ Y_{21} & Y_{22} & Y_{23} \\ Y_{31} & Y_{32} & Y_{33} \end{pmatrix} \begin{pmatrix} C \\ M \\ Y \end{pmatrix} \\[2em] \left\{ \begin{array}{l} C = \boxed{Y_{11} \cdot C} + \boxed{Y_{12} \cdot M} + \boxed{Y_{13} \cdot Y} \\ M = \boxed{Y_{21} \cdot C} + \boxed{Y_{22} \cdot M} + \boxed{Y_{23} \cdot Y} \\ Y = \boxed{Y_{31} \cdot C} + \boxed{Y_{32} \cdot M} + \boxed{Y_{33} \cdot Y} \end{array} \right. \end{array} \right.$$

FIG. 31

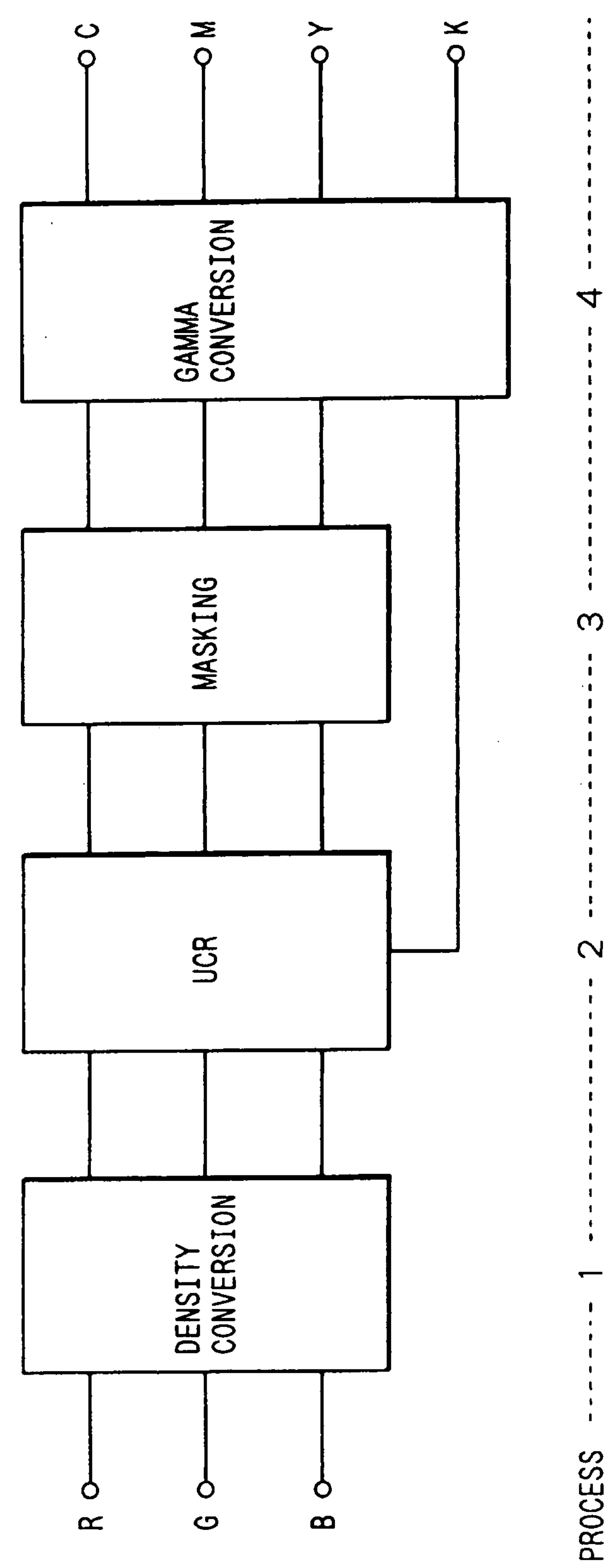

R
G
B
DENSITY CONVERSION
UCR
MASKING
GAMMA CONVERSION
C
M
Y
K
PROCESS
1
2
3
4

FIG. 32

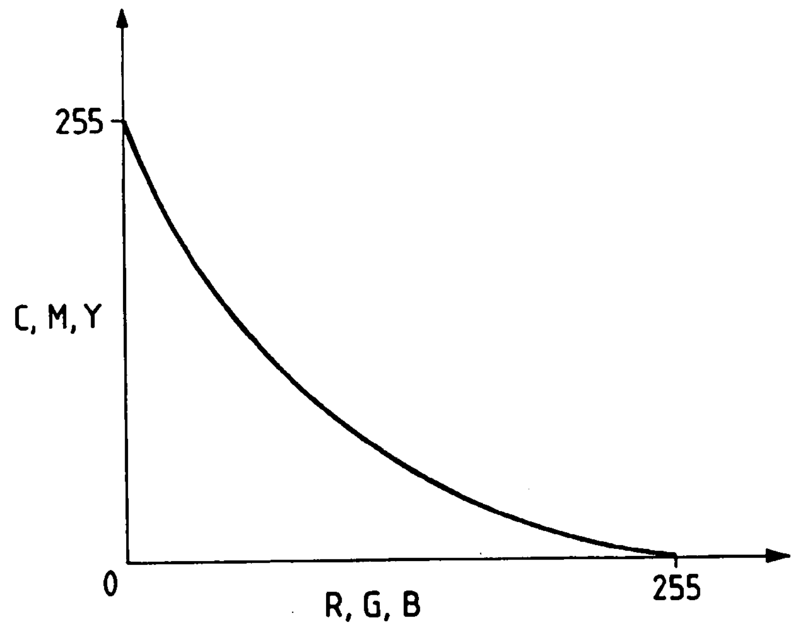


FIG. 33

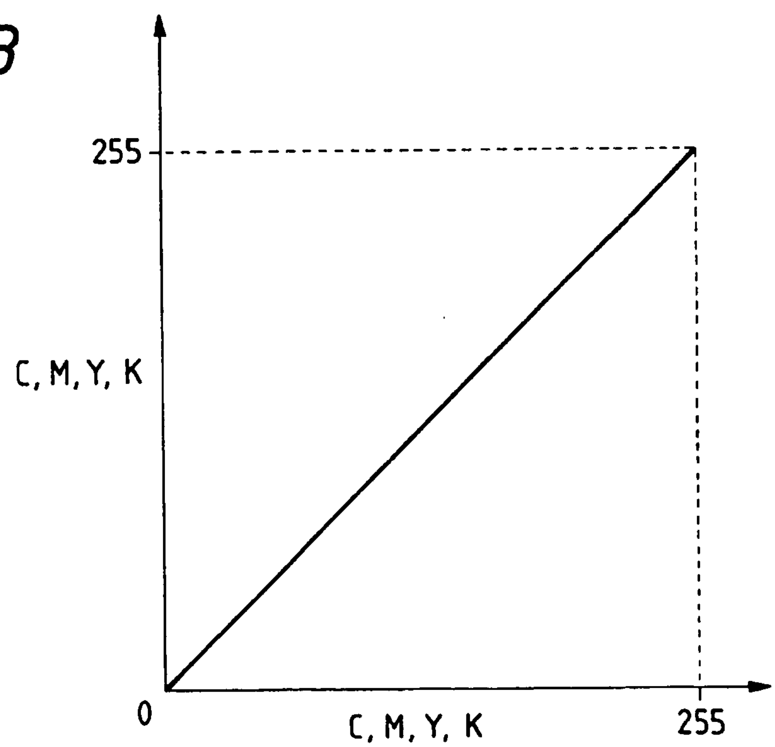


FIG. 35

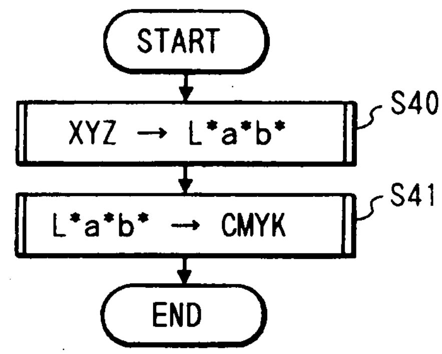


FIG. 36

$$
\left\{
\begin{aligned}
L^* &= \begin{cases} 116\,(Y/Y_n)^{\frac{1}{3}} - 16 & (Y/Y_n > 0.008856) \\ 903.3\,(Y/Y_n) & (Y/Y_n < 0.008856) \end{cases} \\
a^* &= \begin{cases} 500\left[(X/X_n)^{\frac{1}{3}} - (Y/Y_n)^{\frac{1}{3}}\right] & \begin{matrix} X \\ Y \end{matrix}\begin{pmatrix} X_n > 0.008856 \\ Y_n > 0.008856 \end{pmatrix} \\ 500\,[f(X/X_n) - f(Y/Y_n)] & \begin{matrix} X \\ Y \end{matrix}\begin{pmatrix} X_n < 0.008856 \\ Y_n < 0.008856 \end{pmatrix} \end{cases} \\
b^* &= \begin{cases} 200\left[(Y/Y_n)^{\frac{1}{3}} - (Z/Z_n)^{\frac{1}{3}}\right] & (Z/Z_n > 0.008856) \\ 200\,[f(Y/Y_n) - f(Z/Z_n)] & (Z/Z_n < 0.008856) \end{cases} \\
&\text{WHERE, } f(X/X_n) = 7.787\,(X/X_n) + 16/116 \\
&\phantom{\text{WHERE, }} f(Y/Y_n) = 7.787\,(Y/Y_n) + 16/116 \\
&\phantom{\text{WHERE, }} f(Z/Z_n) = 7.787\,(Z/Z_n) + 16/116
\end{aligned}
\right.
$$

FIG. 37

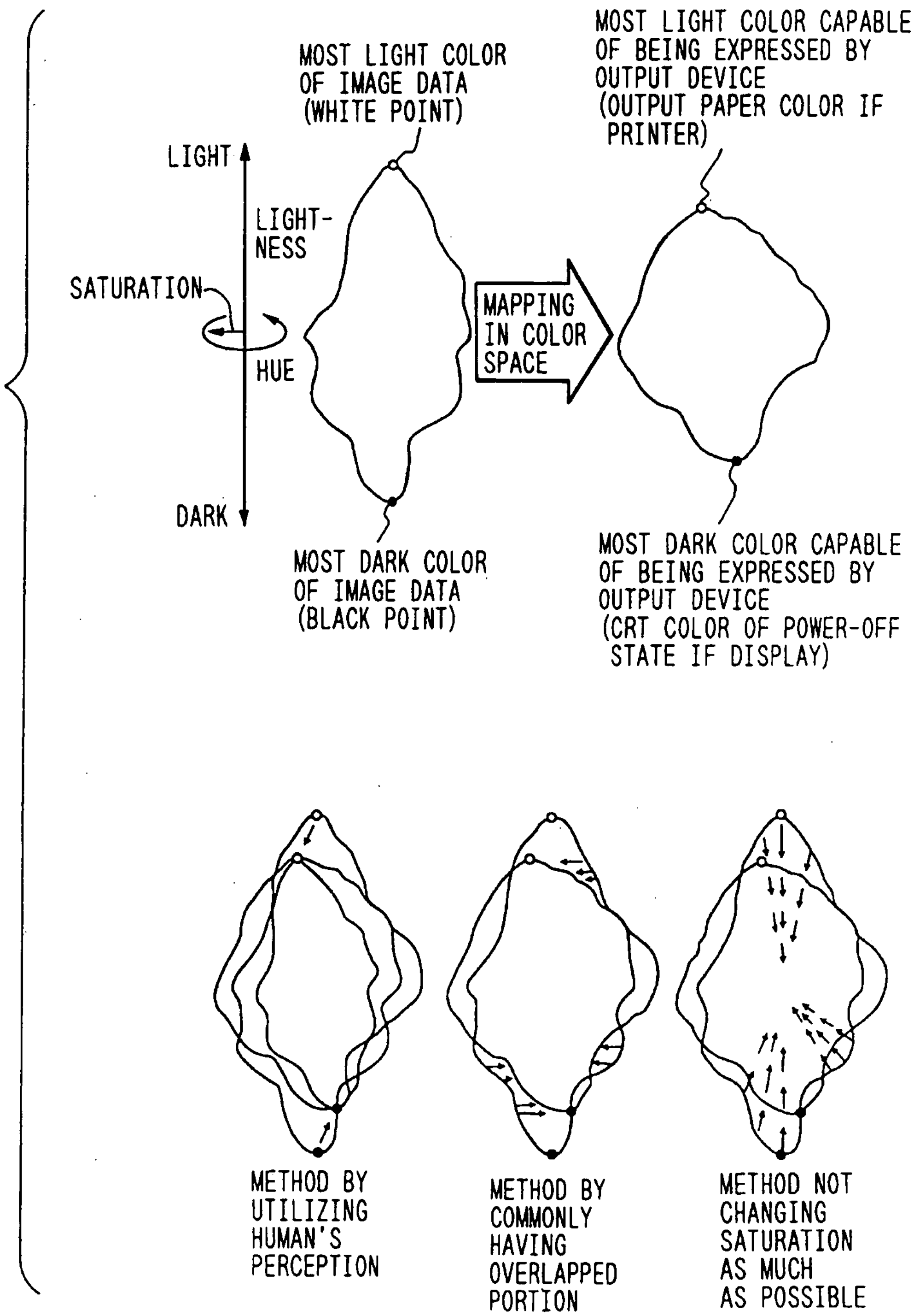
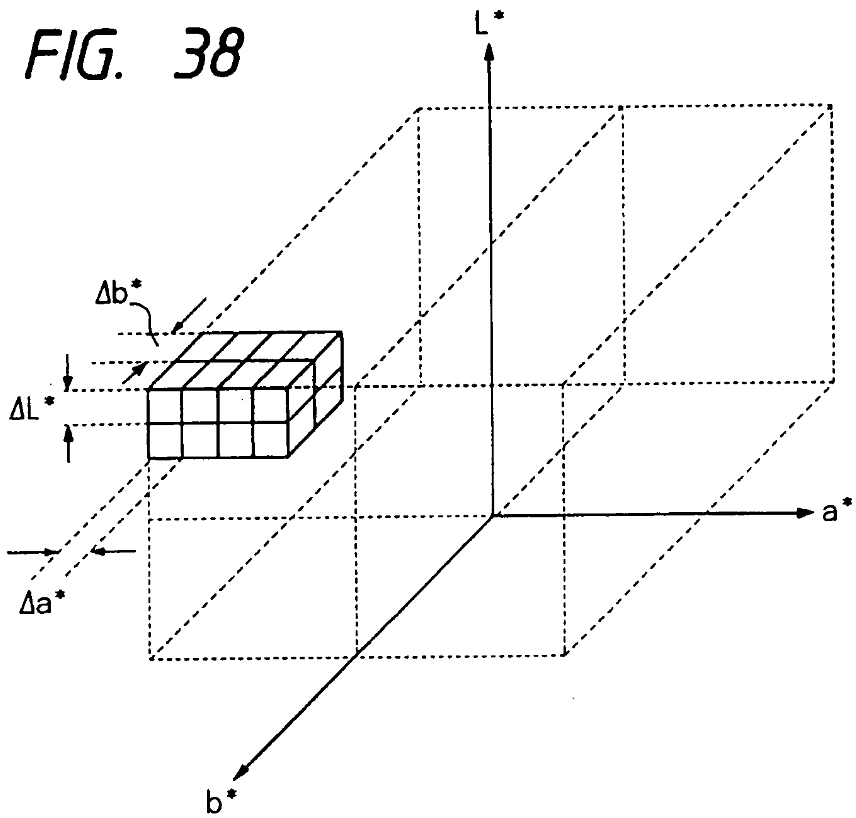
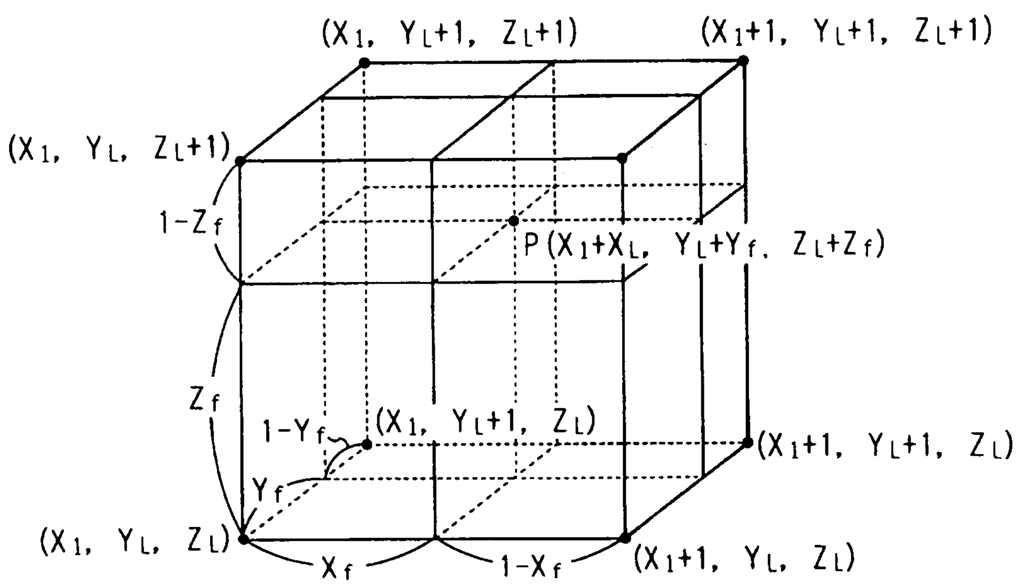

MOST LIGHT COLOR
OF IMAGE DATA
(WHITE POINT)
MOST LIGHT COLOR CAPABLE
OF BEING EXPRESSED BY
OUTPUT DEVICE
(OUTPUT PAPER COLOR IF
PRINTER)
LIGHT
LIGHT-
NESS
SATURATION
HUE
DARK
MAPPING
IN COLOR
SPACE
MOST DARK COLOR
OF IMAGE DATA
(BLACK POINT)
MOST DARK COLOR CAPABLE
OF BEING EXPRESSED BY
OUTPUT DEVICE
(CRT COLOR OF POWER-OFF
STATE IF DISPLAY)
METHOD BY
UTILIZING
HUMAN'S
PERCEPTION
METHOD BY
COMMONLY
HAVING
OVERLAPPED
PORTION
METHOD NOT
CHANGING
SATURATION
AS MUCH
AS POSSIBLE

FIG. 38



L*
Δb*
ΔL*
Δa*
a*
b*

FIG. 39



(X1, YL+1, ZL+1)
(X1+1, YL+1, ZL+1)
(X1, YL, ZL+1)
1-Zf
P (X1+XL, YL+Yf, ZL+Zf)
Zf
1-Yf
(X1, YL+1, ZL)
(X1+1, YL+1, ZL)
Yf
(X1, YL, ZL)
Xf
1-Xf
(X1+1, YL, ZL)

FIG. 40

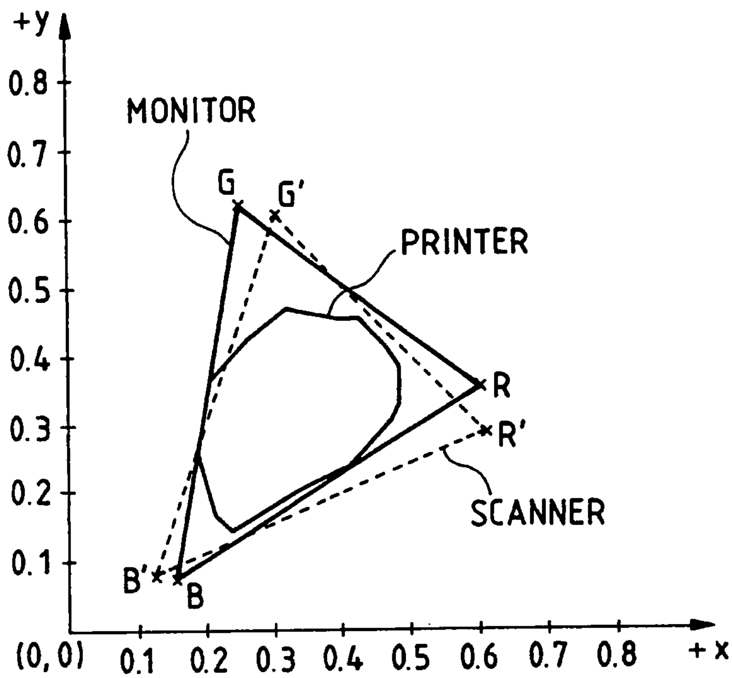


FIG. 42

DEVICE MODEL
DATA SIZE
VERSION
CMM Subtype
Gamut checktype
OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT
OFFSET VALUE FOR INFORMATION STORAGE UNIT FOR DEVICE COLOR GAMUT CHECK

FIG. 41

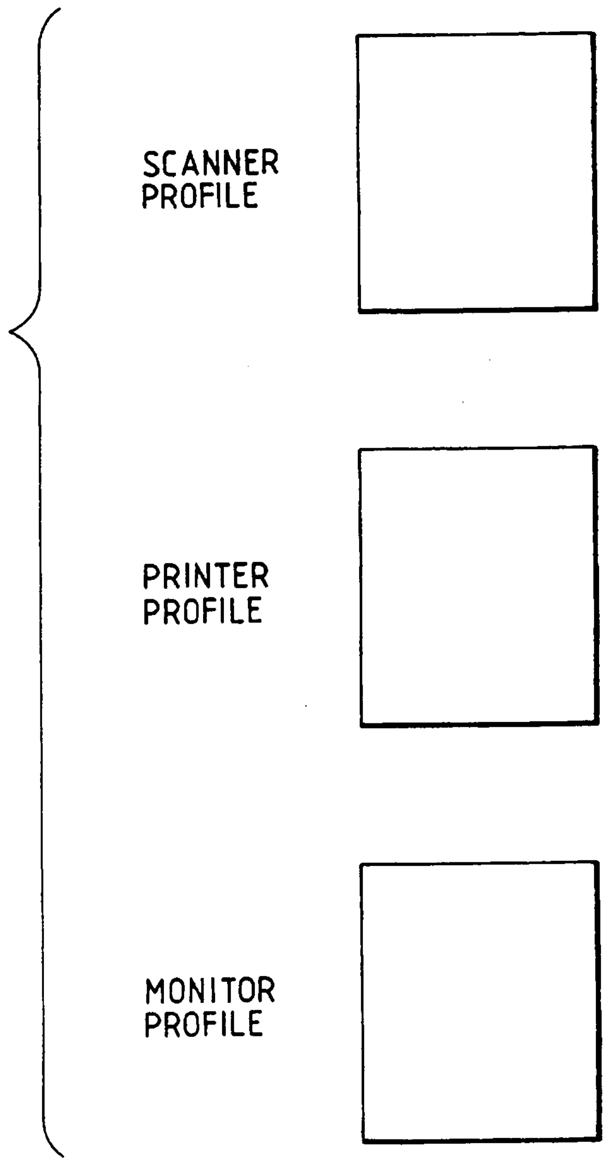


FIG. 43

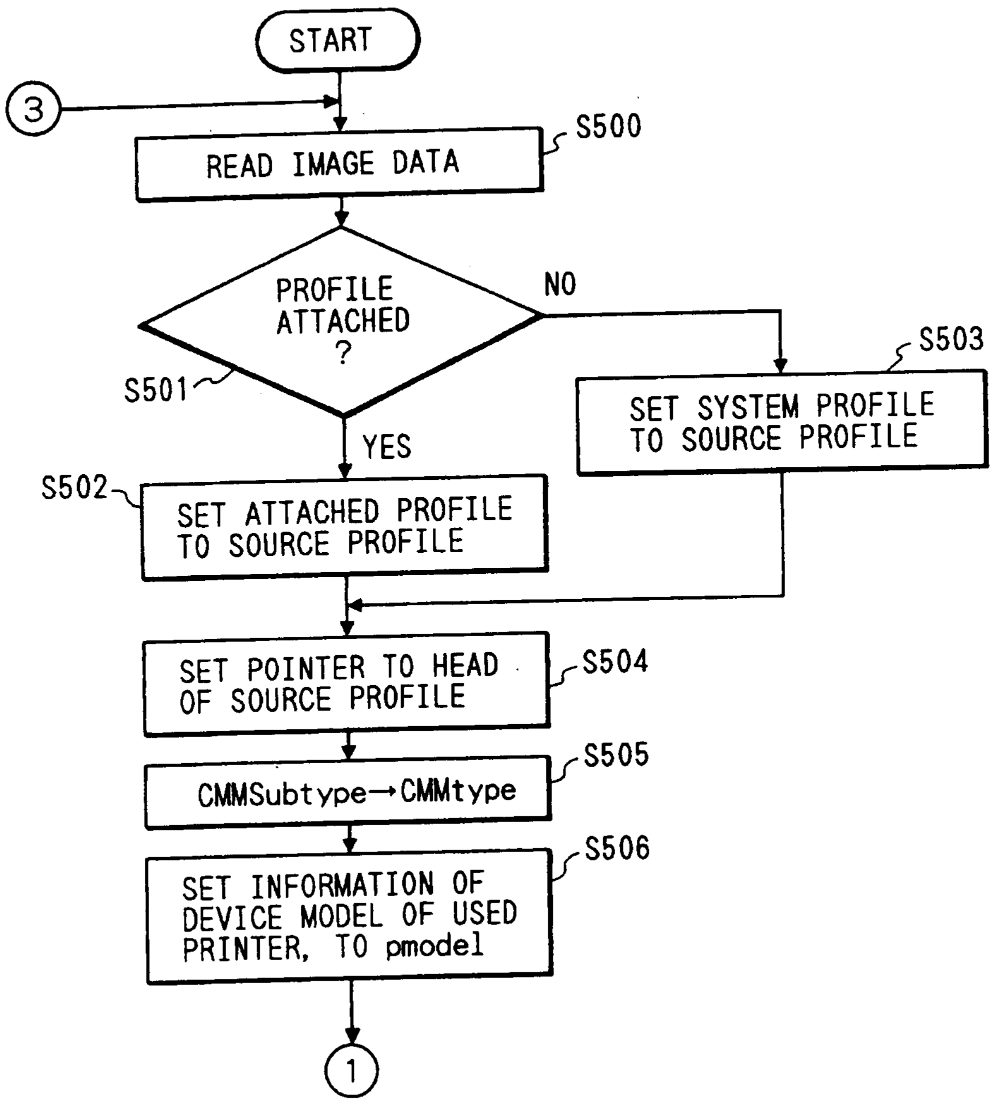

START
3
READ IMAGE DATA
S500
PROFILE ATTACHED ?
NO
S501
S503
SET SYSTEM PROFILE TO SOURCE PROFILE
YES
S502
SET ATTACHED PROFILE TO SOURCE PROFILE
SET POINTER TO HEAD OF SOURCE PROFILE
S504
CMMSubtype→CMMtype
S505
S506
SET INFORMATION OF DEVICE MODEL OF USED PRINTER, TO pmodel
1

FIG. 44

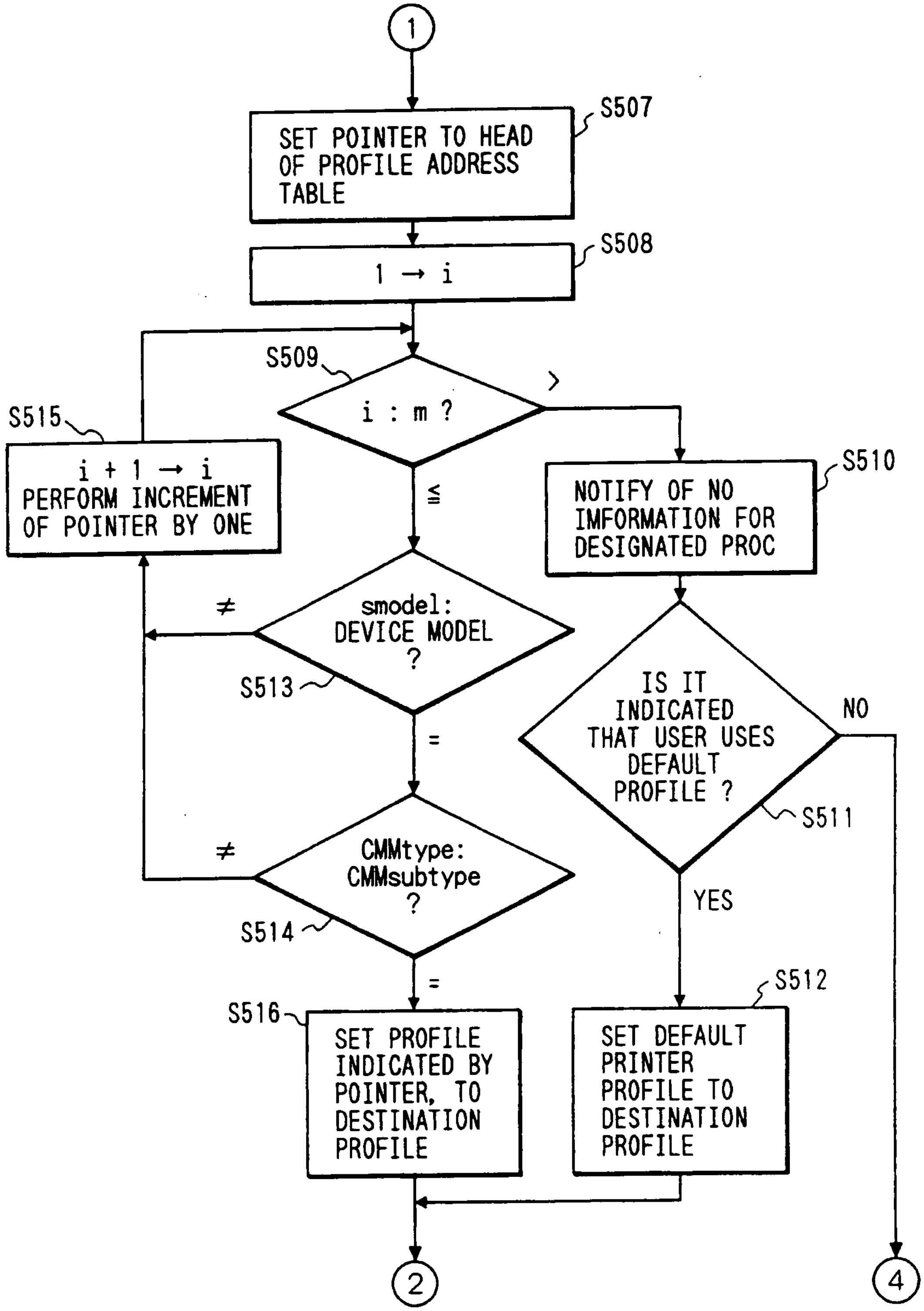

1
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S507
1 → i
S508
S509
i : m ?
>
≦
S515
i + 1 → i
PERFORM INCREMENT OF POINTER BY ONE
NOTIFY OF NO IMFORMATION FOR DESIGNATED PROC
S510
≠
smodel: DEVICE MODEL ?
S513
=
IS IT INDICATED THAT USER USES DEFAULT PROFILE ?
NO
S511
≠
CMMtype: CMMsubtype ?
S514
YES
=
S516
SET PROFILE INDICATED BY POINTER, TO DESTINATION PROFILE
S512
SET DEFAULT PRINTER PROFILE TO DESTINATION PROFILE
2
4

FIG. 45

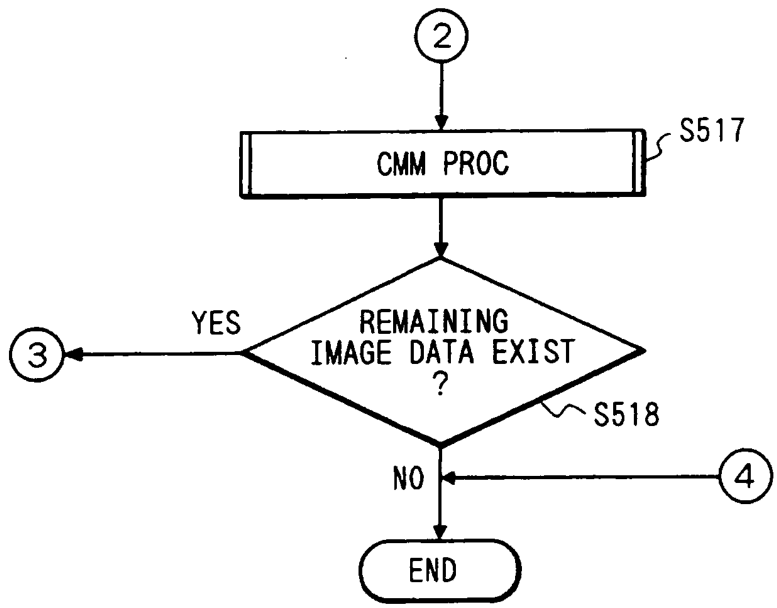

2
CMM PROC
S517
YES
REMAINING IMAGE DATA EXIST ?
3
S518
NO
4
END

FIG. 50

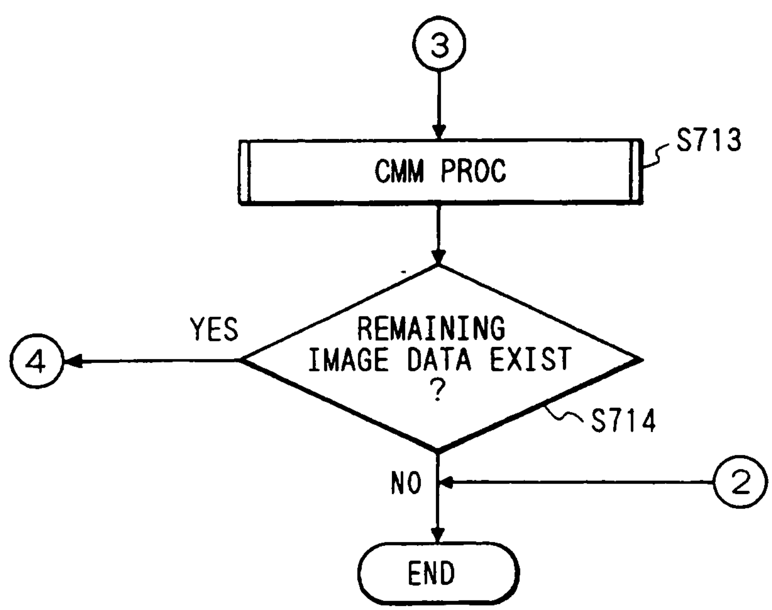

3
CMM PROC
S713
YES
REMAINING IMAGE DATA EXIST ?
4
S714
NO
2
END

FIG. 46

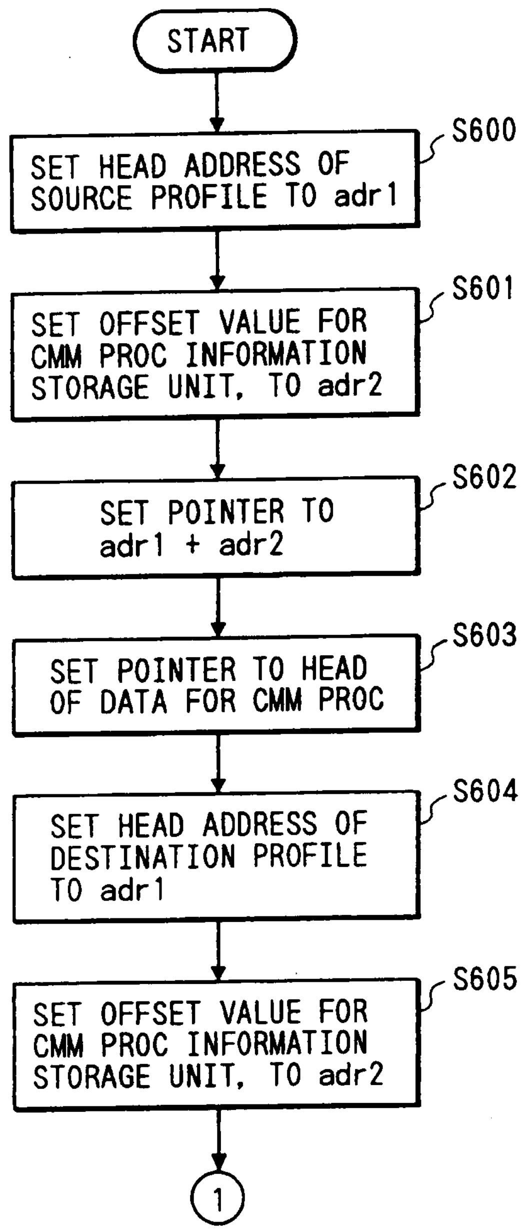

START
SET HEAD ADDRESS OF SOURCE PROFILE TO adr1
S600
SET OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT, TO adr2
S601
SET POINTER TO adr1 + adr2
S602
SET POINTER TO HEAD OF DATA FOR CMM PROC
S603
SET HEAD ADDRESS OF DESTINATION PROFILE TO adr1
S604
SET OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT, TO adr2
S605
1

FIG. 47

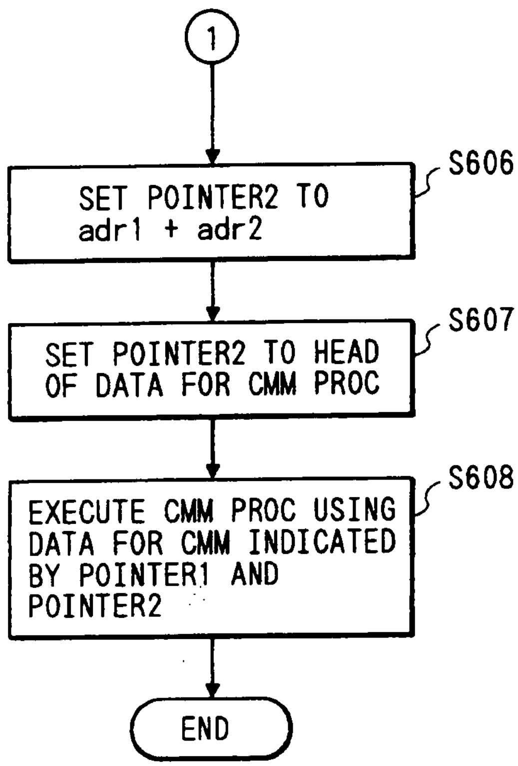

1
SET POINTER2 TO adr1 + adr2
S606
SET POINTER2 TO HEAD OF DATA FOR CMM PROC
S607
EXECUTE CMM PROC USING DATA FOR CMM INDICATED BY POINTER1 AND POINTER2
S608
END

FIG. 48

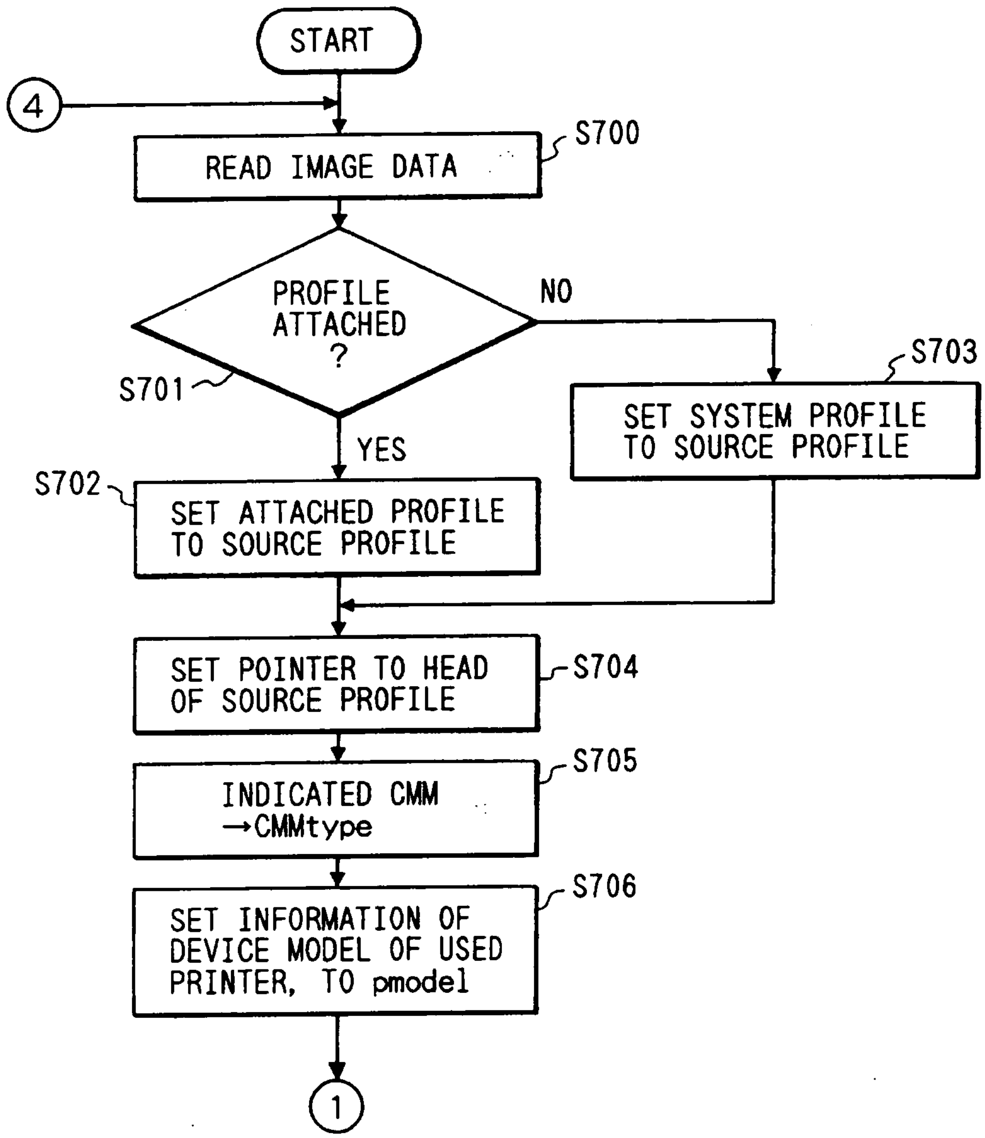

START
4
READ IMAGE DATA
S700
PROFILE ATTACHED ?
NO
S701
S703
SET SYSTEM PROFILE TO SOURCE PROFILE
YES
S702
SET ATTACHED PROFILE TO SOURCE PROFILE
SET POINTER TO HEAD OF SOURCE PROFILE
S704
S705
INDICATED CMM →CMMtype
S706
SET INFORMATION OF DEVICE MODEL OF USED PRINTER, TO pmodel
1

FIG. 49

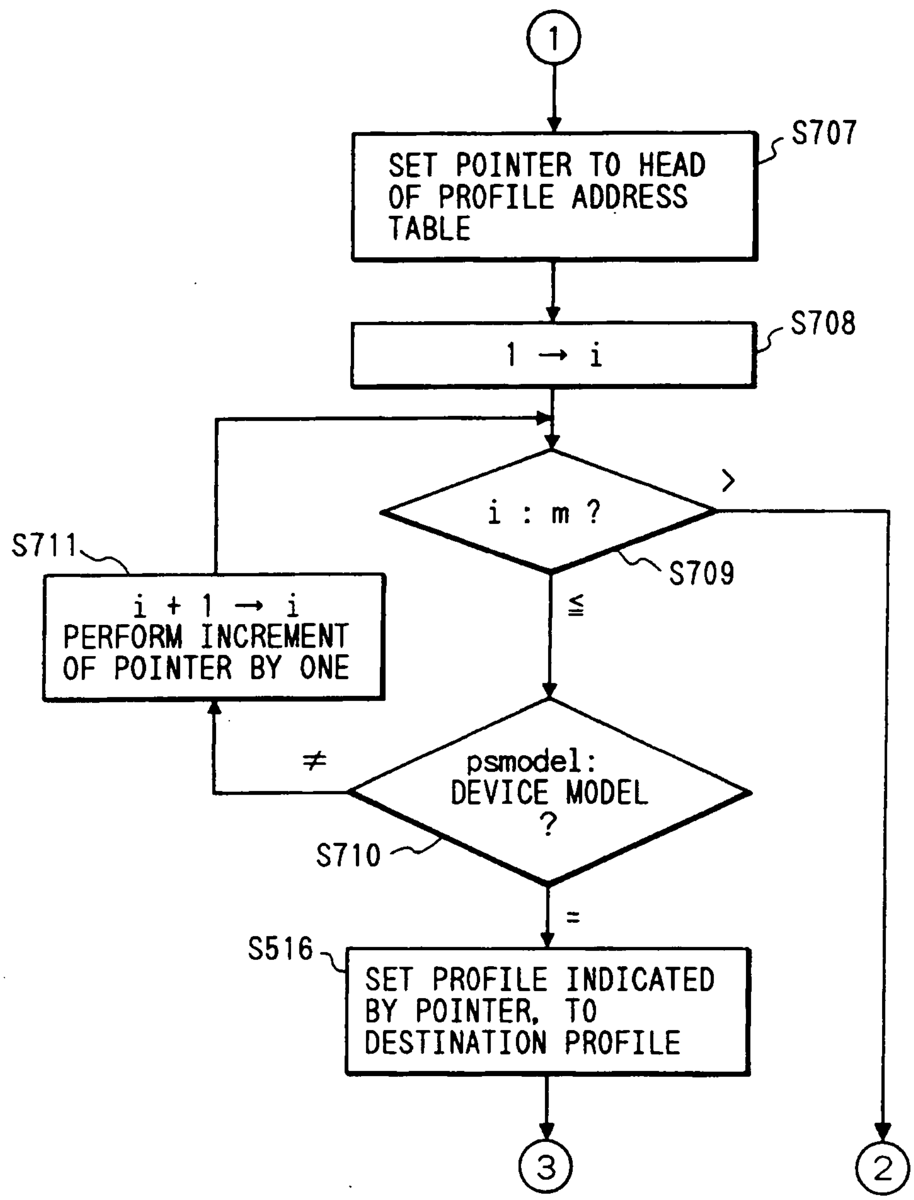

1
SET POINTER TO HEAD OF PROFILE ADDRESS TABLE
S707
1 → i
S708
i : m ?
S709
>
≦
S711
i + 1 → i
PERFORM INCREMENT OF POINTER BY ONE
psmodel:
DEVICE MODEL
?
S710
≠
=
S516
SET PROFILE INDICATED BY POINTER, TO DESTINATION PROFILE
3
2

FIG. 51

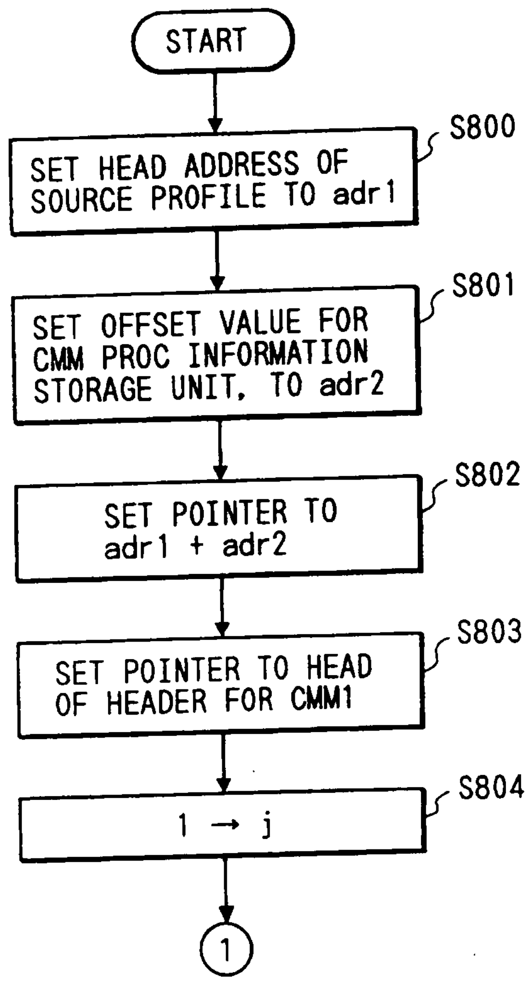

START
SET HEAD ADDRESS OF SOURCE PROFILE TO adr1
S800
SET OFFSET VALUE FOR CMM PROC INFORMATION STORAGE UNIT, TO adr2
S801
SET POINTER TO adr1 + adr2
S802
SET POINTER TO HEAD OF HEADER FOR CMM1
S803
1 → j
S804
1

FIG. 52

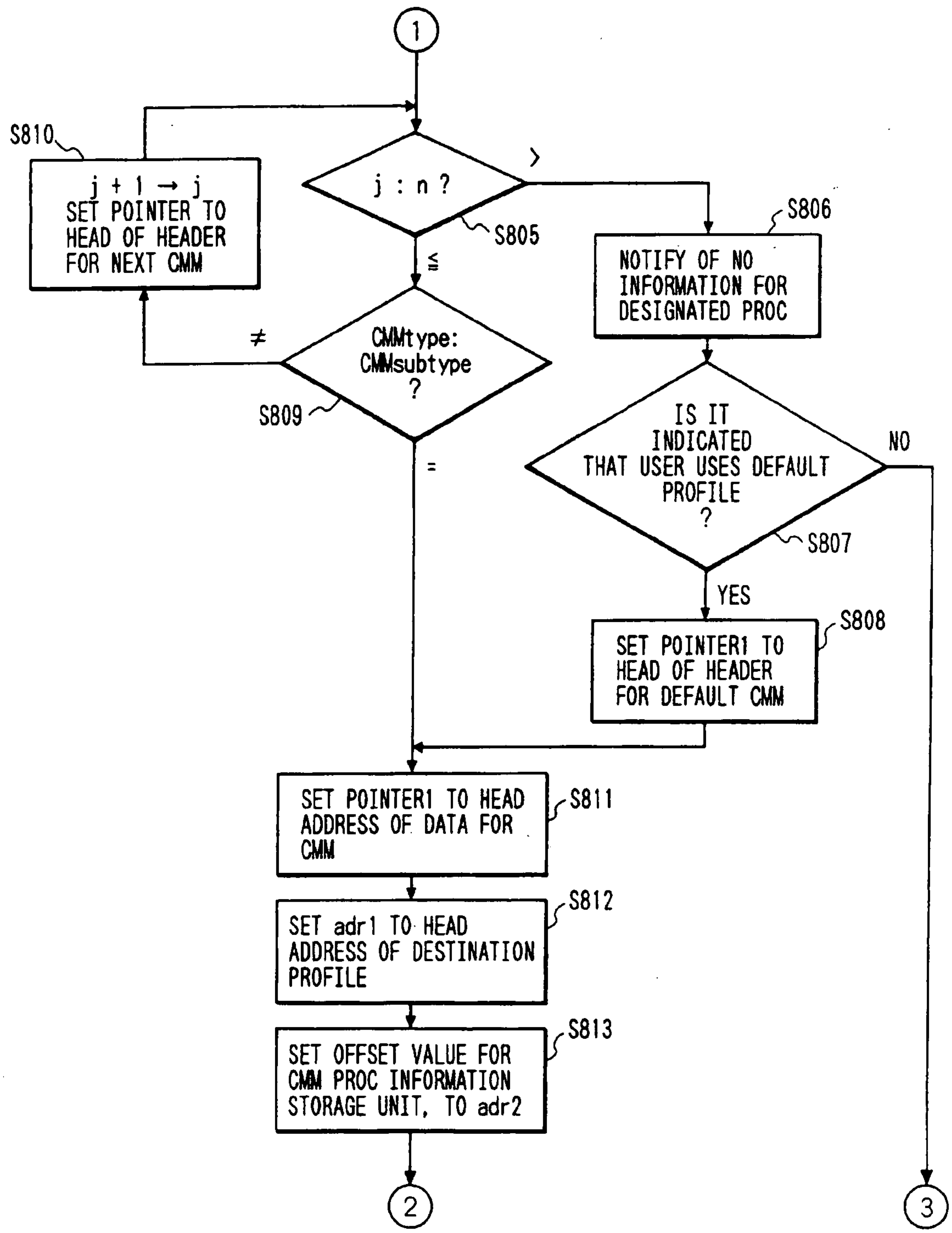
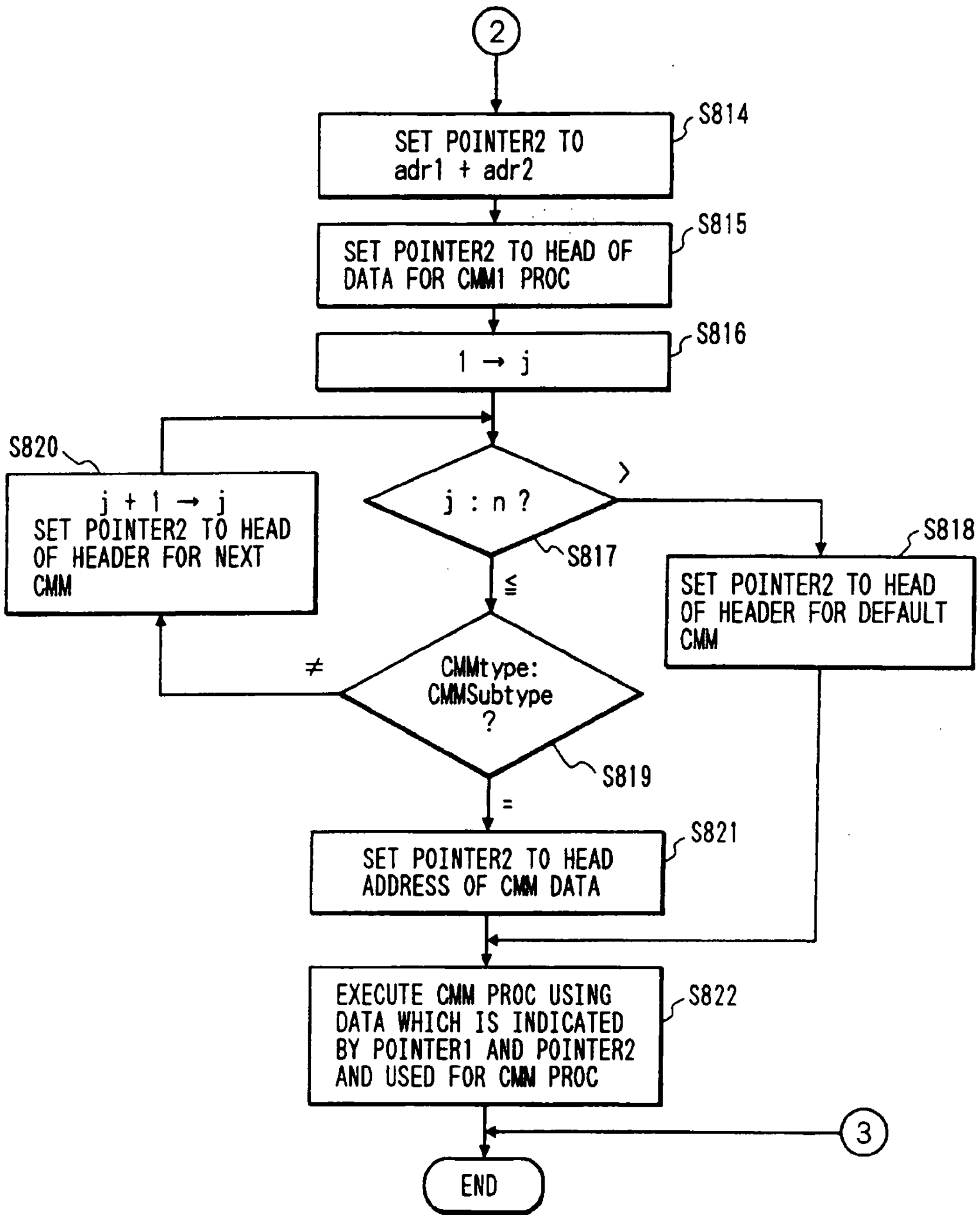

1
S810
j + 1 → j
SET POINTER TO
HEAD OF HEADER
FOR NEXT CMM
j : n ?
S805
>
≤
S806
NOTIFY OF NO
INFORMATION FOR
DESIGNATED PROC
≠
CMMtype:
CMMsubtype
?
S809
=
IS IT
INDICATED
THAT USER USES DEFAULT
PROFILE
?
S807
NO
YES
S808
SET POINTER1 TO
HEAD OF HEADER
FOR DEFAULT CMM
SET POINTER1 TO HEAD
ADDRESS OF DATA FOR
CMM
S811
SET adr1 TO HEAD
ADDRESS OF DESTINATION
PROFILE
S812
SET OFFSET VALUE FOR
CMM PROC INFORMATION
STORAGE UNIT, TO adr2
S813
2
3

FIG. 53



2
SET POINTER2 TO adr1 + adr2
S814
SET POINTER2 TO HEAD OF DATA FOR CMM1 PROC
S815
1 → j
S816
S820
j + 1 → j SET POINTER2 TO HEAD OF HEADER FOR NEXT CMM
j : n ?
>
S817
≦
SET POINTER2 TO HEAD OF HEADER FOR DEFAULT CMM
S818
≠
CMMtype: CMMSubtype ?
S819
=
SET POINTER2 TO HEAD ADDRESS OF CMM DATA
S821
EXECUTE CMM PROC USING DATA WHICH IS INDICATED BY POINTER1 AND POINTER2 AND USED FOR CMM PROC
S822
3
END